

Popular Science®

The **What's New** magazine

Sun-powered planes

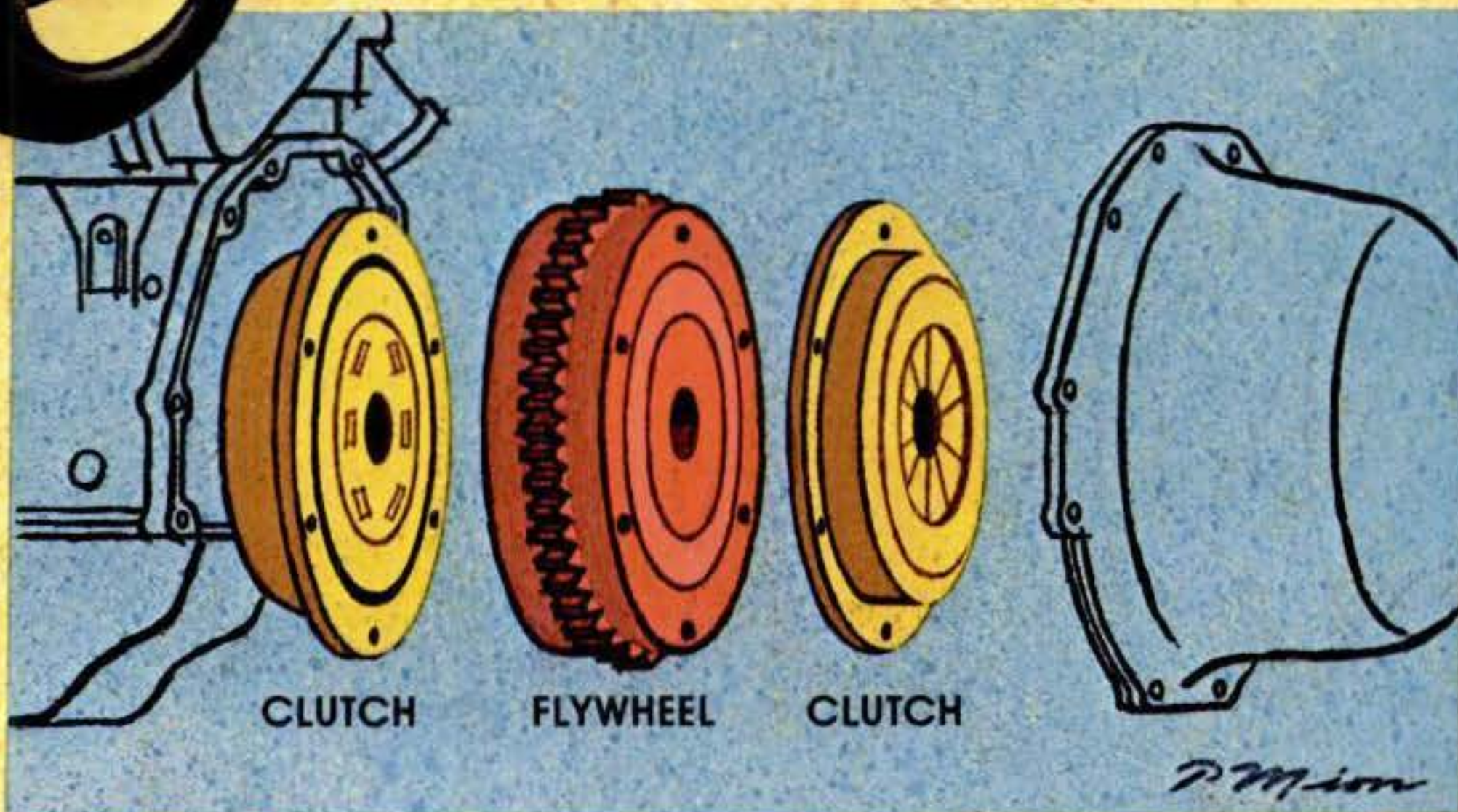
test-fly on two continents

VW's 21st-CENTURY CAR

Optical vs. mechanical:
the coming battle of the
VIDEO-DISC
PLAYERS

Tough protective
hardware for
WINDOWS AND
PATIO DOORS

Better pest control with
UV BUG KILLERS



VW's ingenious stop/start transmission



A full-page photograph of a cowboy in a white hat and vest riding a brown horse. The cowboy is looking towards the camera with a cigarette in his mouth. The background shows a vast, hazy landscape with mountains under a blue sky. In the lower right, two packs of Marlboro cigarettes are superimposed over the image.

Come to Marlboro Country.



Marlboro Red or Longhorn 100's—
you get a lot to like.

Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

17 mg "tar," 1.1 mg nicotine
av. per cigarette, FTC Report Dec '79

a \$5 LCD digital

NOW WITH STOP WATCH WATCH

Try only 10 DAK high energy 90 minute cassettes risk free for just \$2.19 each and get a beautiful \$69 value LCD digital watch for only \$5!

YOU CAN'T LOSE!!! IF YOU'RE NOT 100% SATISFIED, KEEP AN ML90 FREE AS A GIFT FOR TRYING OUR CASSETTES!!!

Are the very high frequencies disappearing from your cassettes as you play them? Friction within your cassettes may be erasing your crystal clear highs even as you read this ad.

DAK developed a jam proof cassette for professional high speed duplicators and in the process discovered why recordings that sound great when you make them, may sound less than great in just a few months.

Here's a chance to try DAK ML90s risk free and pick up a great LCD watch complete with stop watch for only \$5!

YOUR TIME IS PRECIOUS

Imagine yourself just finishing recording the second side of a 90 minute cassette and horrors, the cassette jams. Tape is wound around the capstan, your recorder may be damaged and you've just wasted 90 minutes of your time and perhaps lost a great recording off FM.

MOLYSULFIDE

DAK manufactures enough tape for over one million cassettes per month, mostly for professional duplicators and loaders. We developed polyester slip sheets which are inside the cassette with raised spring loaded ridges to guide each layer of tape as it winds so it won't jam.

We coat the liners with a unique formulation of graphite and a new chemical called molysulfide. It reduces friction several times better than graphite and allows the tape to move more freely within the the cassette.

HIGH FREQUENCY PROTECTION

Tape is basically plastic, and as it moves within the cassette friction causes the build up of static electricity, much as scuffing your shoes on a carpet in dry weather.

Static electricity within the cassette is drastically reduced by the low friction of the molysulfide so that it won't erase crystal clear highs. A very important consideration for often played tapes.

MAXELL 'TAPE' IS BETTER

Yes, honestly, if you own a \$1000 cassette deck like a Nakamichi, the frequency responses of Maxell UDXL or TDK SA are superior and you just might be able to hear a difference.

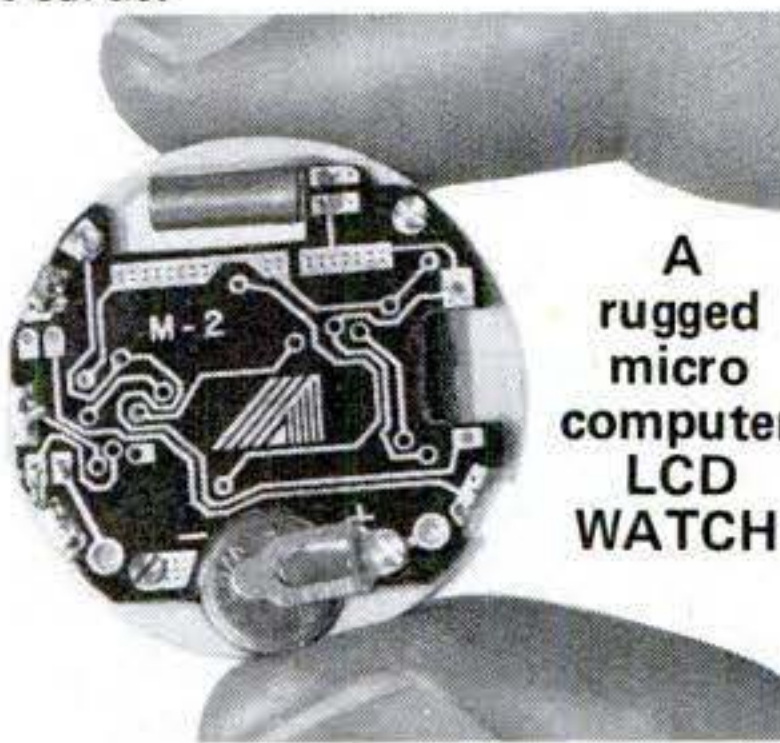
DAK ML has a frequency response that is flat from 40hz to 14,500hz ± 3 db. Virtually all cassette recorders priced under \$600 are flat ± 3 db only from 40hz to about 12,500hz, so we

have over 2000hz to spare, and you'll probably never notice the difference, and we feel that we have equaled or exceeded the mechanical reliability of virtually all cassettes.

NOT MAGICAL OR CHEAP

DAK manufactures the tape we sell. Our tape really doesn't cost less to make. You only avoid paying the wholesaler and retailer costs and profits. When a cassette leaves other factories, it must be marked up each step of the way; even duty on some of the fine imported cassettes must be added, so with DAK tape you really only save the middlemen profits.

While Maxell UDXL 90s may sell for \$3.50 to \$4.50 each at retail, DAK ML90s sell factory direct to you for only \$2.19 each complete with deluxe all clear hard plastic boxes and index insert cards.



A rugged micro computer LCD WATCH

A \$5 LCD WATCH++STOP WATCH?

This beautifully styled slim silvertone watch is loaded with features. LCD means that the time in hours and minutes always shows without having to push buttons.

Push the button once, and you'll see the date in months and days, and push the button again and see seconds. Push the second button and the entire time section lights up for convenient night viewing.

Stop watch feature. This fine watch has a third button which starts and stops an accurate stop watch. The stop watch displays up to 15 minutes and then continues running displaying up to 15 minutes at a time. It's great for timing cassettes.

Quartz crystal accuracy means constant time within 1 minute per month. Crystals use little electricity, so the

battery should last up to a year, and is easily changed.

Stainless steel band for long life and comfort. No imitation, a first rate locking adjustable band.

It's guaranteed. This fine watch comes with a manufacturer's limited warranty, good for one full year.

DAK TAKES A RISK

Obviously giving away quality watches is not going to make DAK rich. We are betting that once you get our new 40 page catalog with over 6000 words about how to make better recordings, you will want to buy our cassettes again, and we are putting our money where our mouth is!

Customers like you are very valuable in the form of future business. We anticipate receiving over 6000 orders and over 4500 repeat customers from this advertisement to add to our list of over 80,000.

TRY DAK ML90 CASSETTES RISK FREE

Try these high energy cassettes on your own recorder without obligation for 30 days. If you aren't 100% satisfied for any reason, return only 9 of them and the watch for a refund. The cassette you test recorded is yours as a gift.

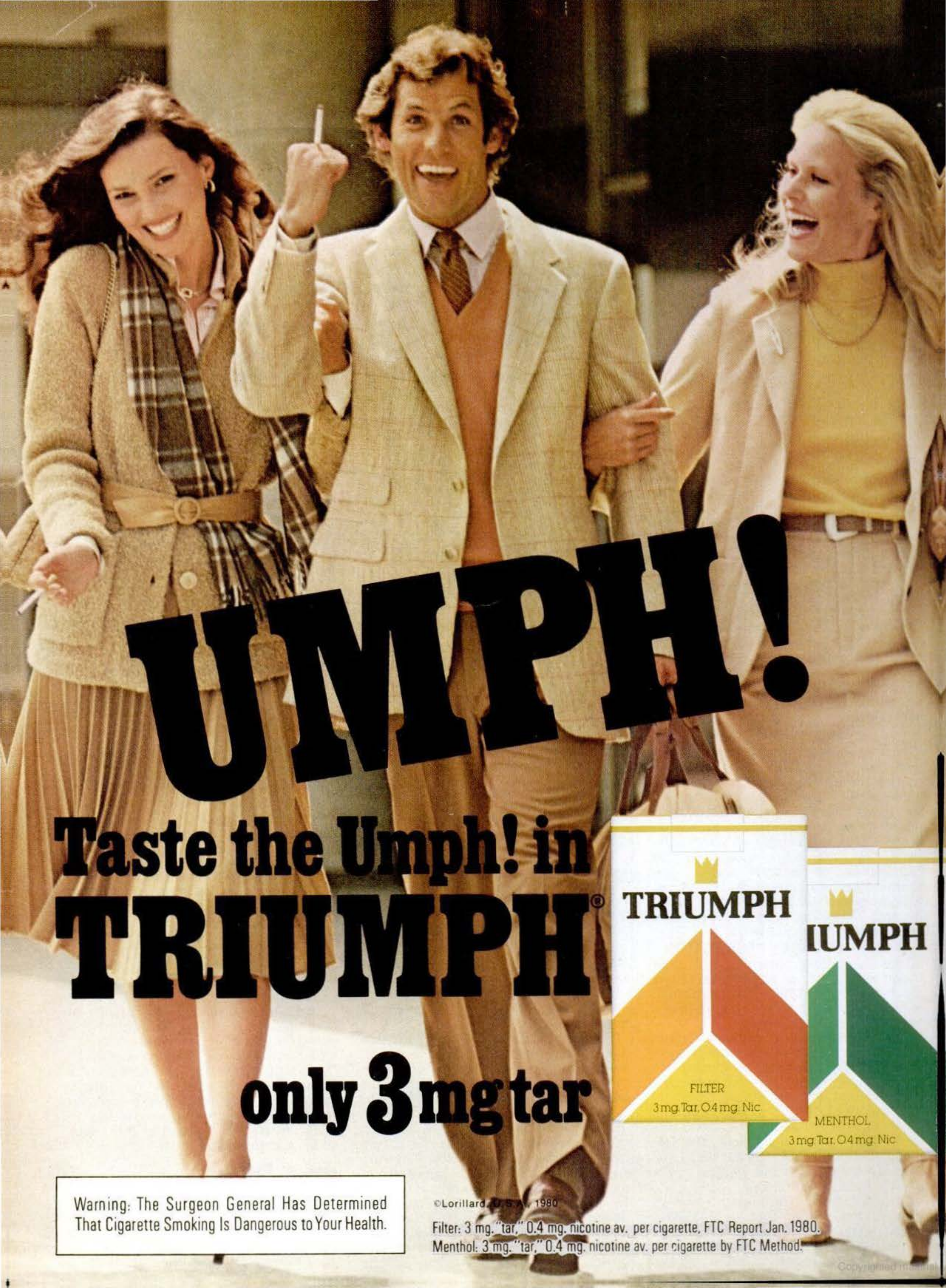
To order your 10 DAK ML 90 minute high energy cassettes at \$2.19 each and get the LCD digital watch for only \$5 with your credit card, simply call the toll free number below, or send your check for only \$21.90 plus \$5 for the watch and \$3 for postage and handling for each group to DAK. (CA residents add 6% sales tax).

DAK unconditionally guarantees all DAK cassettes for one year against any defects in material or workmanship.

Why not order an extra group of 10 DAK ML90 cassettes for yourself or a friend? We will add one free ML90 cassette to each additional group you buy and of course you can still get an LCD watch for only \$5 with each additional group you order.

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Menthol: 3 mg. "tar," 0.4 mg. nicotine av. per cigarette by FTC Method.

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STEREO BREAKTHROUGH



Bone Fone^{T.M.}

*A new concept in sound technology
may revolutionize the way we
listen to stereo music.*

*The Bone Fone surrounds your entire body
with a sound almost impossible to imagine.*

You're standing in an open field. Suddenly there's music from all directions. Your bones resonate as if you're listening to beautiful stereo music in front of a powerful home stereo system.

But there's no radio in sight and nobody else hears what you do. It's an unbelievable experience that will send chills through your body when you first hear it.

AROUND YOU

And nobody will know you're listening to a stereo. The entire sound system is actually draped around you like a scarf and can be hidden under a jacket or worn over clothes.

The Bone Fone is actually an AM/FM stereo multiplex radio with its speakers located near your ears. When you tune in a stereo station, you get the same stereo separation you'd expect from earphones but without the bulk and inconvenience. And you also get something you won't expect.

INNER EAR BONES

The sound will also resonate through your bones—all the way to the sensitive bones of your inner ear. It's like feeling the vibrations of a powerful stereo system or sitting in the first row listening to a symphony orchestra—it's breathtaking.

Now you can listen to beautiful stereo music everywhere—not just in your living room. Imagine walking your dog to beautiful stereo music or roller skating to a strong disco beat.

You can ride a bicycle or motorcycle, jog and even do headstands—the Bone Fone stays on no matter what the activity. The Bone Fone stereo brings beautiful music and convenience to every indoor and outdoor activity without disturbing those around you and without anything covering your ear.

SKI INVENTION

The Bone Fone was invented by an engineer who liked to ski. Every time he took a long lift ride, he noticed other skiers carrying transistor radios and cassette players and wondered if there was a better way to keep your hands free and listen to stereo music.

So he invented the Bone Fone stereo. When he put it around his neck, he couldn't believe his ears. He was not only hearing the music

and stereo separation, but the sound was resonating through his bones giving him the sensation of standing in front of a powerful stereo system.

AWARDED PATENT

The inventor took his invention to a friend who also tried it on. His friend couldn't believe what he heard and at first thought someone was playing a trick on him.

The inventor was awarded a patent for his idea and brought it to JS&A. We took the idea and our engineers produced a very sensitive yet powerful AM/FM multiplex radio called the Bone Fone.

The entire battery-powered system is self-contained and uses four integrated circuits and two ceramic filters for high station selectivity. The Bone Fone weighs only 15 ounces, so when worn over your shoulders, the weight is not even a factor.

BUILT TO TAKE IT

The Bone Fone was built to take abuse. The large 70 millimeter speakers are protected in flexible water and crush resistant cases. The case that houses the radio itself is made of rugged ABS plastic with a special reinforcement system. We knew that the Bone Fone stereo may take a great deal of abuse so we designed it with the quality needed to withstand the worst treatment.

The Bone Fone stereo is covered with a sleeve made of Lycra Spandex—the same material used to make expensive swim suits, so it's easily washable. You simply remove the sleeve, dip it in soapy water, rinse and let the sleeve dry. It's just that easy. The entire system is also protected against damage from moisture and sweat making it ideal for jogging or bicycling.

The sleeve comes in brilliant Bone Fone blue—a color designed especially for the system. An optional set of four sleeves in orange, red, green and black is also available for \$10. You can design your own sleeve using the pattern supplied free with the optional kit.

YOUR OWN SPACE

Several people could be in a car, each tuned to his own program or bring the Bone Fone to a ball game for the play by play. Cyclists,

joggers, roller skaters, sports fans, golfers, housewives, executives—everybody can find a use for the Bone Fone. It's the perfect gift.

Why not order one on our free trial program and let your entire family try it out? Use it outdoors, while you drive, at ball games or while you golf, jog or walk the dog. But most important—compare the Bone Fone with your expensive home stereo system. Only then will you fully appreciate the major breakthrough this product represents.

GET ONE SOON

To order your Bone Fone, simply send your check or money order for **\$69.95** plus \$2.50 postage and handling to the address shown below. (Illinois residents add 5% sales tax.) Credit card buyers may call our toll-free number below. Add \$10 if you wish to also receive the accessory pack of four additional sleeves.

We'll send you the entire Bone Fone stereo complete with four AA cell batteries, instructions, and 90-day limited warranty including our prompt service-by-mail address.

When you receive your unit, use it for two weeks. Take it with you to work, or wear it in your car. Take walks with it, ride your bicycle or roller skate with it. Let your friends try it out. If after our two-week free trial, you do not feel that the Bone Fone is the incredible stereo experience we've described, return it for a prompt and courteous refund, including your \$2.50 postage and handling. You can't lose and you'll be the first to discover the greatest new space-age audio product of the year.

Discover the freedom, enjoyment, and quality of the first major breakthrough in portable entertainment since the transistor radio. Order a Bone Fone stereo at no obligation, today.

*Pending FCC approval.

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Now you can create country fresh air in your home or office. And also watch cigarette smoke, pollen, dust, and other airborne particles disappear from your environment, for less than three cents a week.

All it takes is a small 2½ pound pollution fighter named Ionosphere™. Which, we're convinced, is the most superbly engineered under \$200 air ionizer on the market today. Bar none.

The Sharper Image is offering Ionosphere through the mail for just \$89.

Ionosphere purifies the air you breathe more efficiently than any fan, exhaust unit or conventional filter system

by creating a negative electrical field. One 4-inch unit will ionize up to 250 square feet, or an average 12' x 20' room. This negative charge acts on floating particles—even invisible ones—causing them to cluster, fall to the floor or adhere to nearby surfaces. The air becomes pure, feels almost "washed." And Ionosphere is so efficient it requires no fan or other moving parts to disperse these ions.

You probably have experienced this fresh-air feeling before. In nature, negative ions are continually recreated by the dynamic action of the sun, rain and lightning. It's why air smells sweet and invigorating after a thunderstorm, or deep in a forest.

Born in academia.

Major ion research has been conducted at the University of California, Berkeley. Ion Systems, Inc., a private company, was founded to manufacture ionizers to the rigorous standards of this research community. Headed by senior engineer D.A. Gehlke (formerly with the government's Polaris Project), I.S.I. has built almost every hospital ion system in the U.S. Their new portable Ionosphere is constructed with this same level of integrity.

Ionosphere's electronics are both superb and unique. It is the only ionizer that uses "passive multi-stage" circuitry for its noiseless and noninterfering output (many units are known to affect radio reception). Most other units use a "vibration" mechanism, which causes clicks, pops or an annoying high-pitched whine.



Power use: approximately 3 watts. Total ion output: 3.8×10^{12} ions/sec. Ion density: 10,000 ions/cubic centimeter at 8'. Ozone production: less than .03 ppm. N_2O production: not measurable.

The circuitry is embedded in epoxy resin, then encapsulated in an impact-resistant sphere—a solid seamless ball of fine ceramic tile. Hermetically sealed, it is protected from the moisture that inevitably reduces the performance of competitive units. We know of no other company that takes

such pains in producing their product.

Other significant differences? For one, a vastly superior ion emitter than you'll find elsewhere. This easily removable element is made from surgical stainless steel bristle, not the more commonly used copper "fuzz" or nickel-plated points. Stainless steel is known for its excellent durability, and this special design guarantees years of consistent ion output. The Ionosphere's emitter will last a lifetime, and cleans easily under hot water.

On other units, you'll also find inexpensive plastic cases. When exposed to a high voltage field, these petrochemicals can be converted to a harmful gas. But Ionosphere's tile case is completely safe.

More ions aren't necessarily better.

One 4" Ionosphere generates approximately 3.8 trillion ions every second. Unlike other units which produce an excessively high output (at the source only), the Ionosphere creates a more *naturally* balanced ion environment. You should also avoid units without stated levels of ozone production (Ionosphere is among the lowest).

Why do we need ionizers at all?

Urban life has upset the natural electrical balance of the air. Modern conveniences like heating, air conditioning, telephones and televisions greatly deplete negative ion levels, robbing the air of its natural cleansers. This is also why we feel uncomfortable under fluorescent lights.

Ionosphere restores this balance in just minutes. The air smells good again, even after smoking.

And, as a result of its work, you may need to clean your walls in a year or so. But be glad that same soot was kept out of your lungs.

Try one, or order a system.

The \$89 Ionosphere comes in white (#946) or black ceramic (#945). Or you may expand your fresh air environment at an \$18 savings—with three units at \$249; 2 white, one black, (#947). Either way, you can experience the freshest air you've probably ever breathed, without obligation. Ionosphere comes with full instructions and a one year warranty. And if you're not delighted, simply return your order within two weeks for a prompt and courteous refund.

ORDER NOW TOLL FREE.

Credit card holders may call the toll-free ordering number, seven days a week, anytime. Please have the product number ready. Or send your check, adding sales tax in CA (5.34 for one, 14.94 for three). Plus \$3.50 delivery. Please order now to insure early delivery.

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JULY 1980
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The **What's New** magazine

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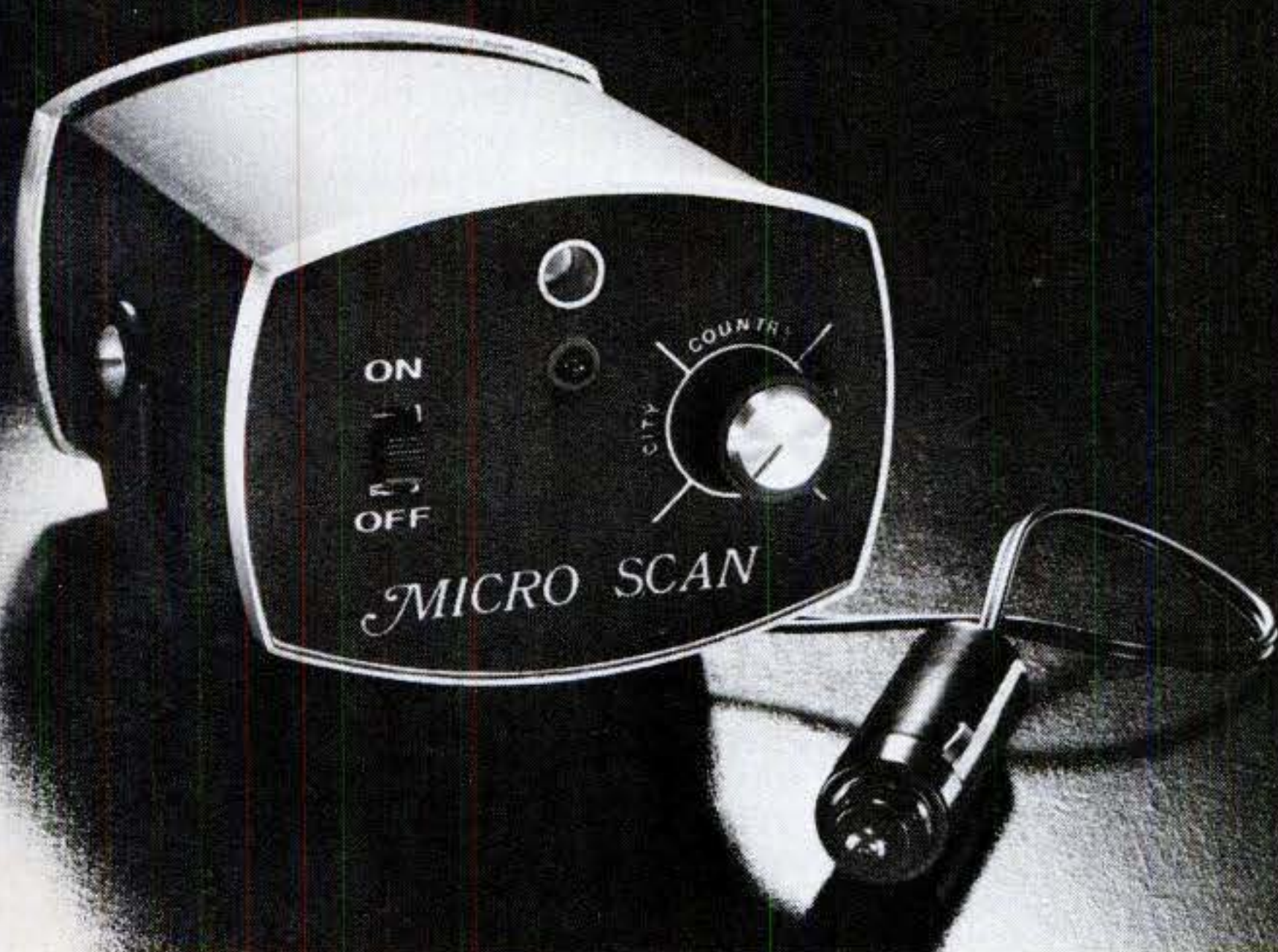
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POLICE RADAR MEETS ITS MATCH.

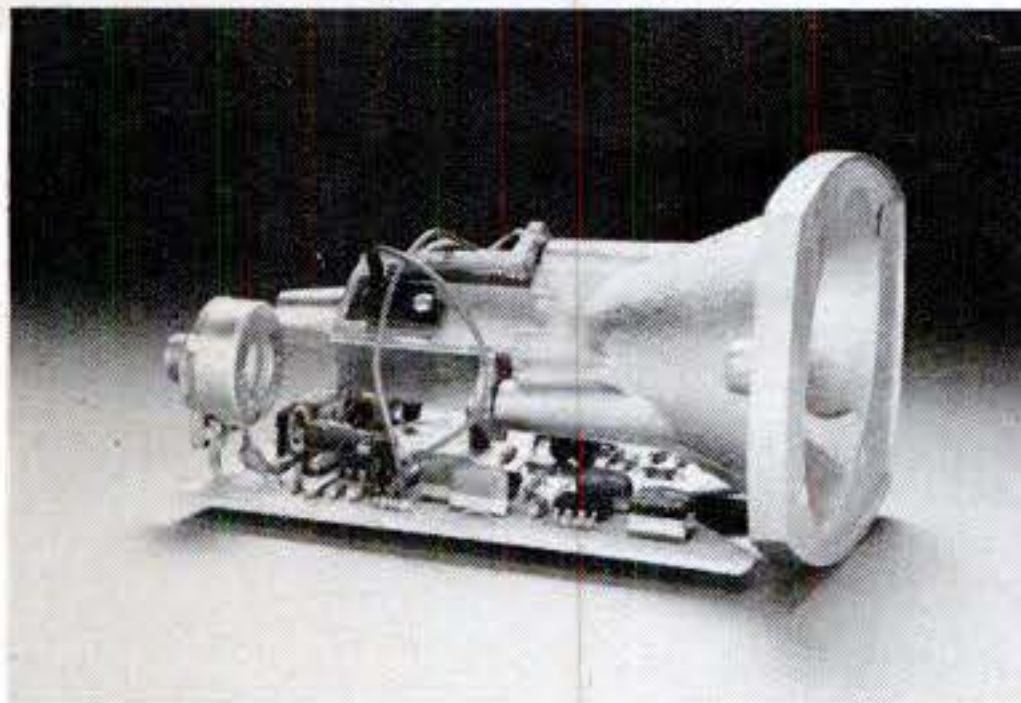


You can't buy a better radar detector for \$95 than the GUL Micro Scan. Developed by B.E.L. Laboratories after 10 years of research, the GUL Micro Scan has repeatedly proven its superior signal sensitivity. In separate tests conducted by Canadian Tire Corporation and *Motor Consumer Report*, it demonstrated a detection distance significantly greater (on both X and K bands) than its top three competitors—the Fuzzbuster XK, the Whistler XK and the XK Snooper.

That was only the beginning.

Plenty of advance warning.

In two recent issues (January and February, 1980) *CB Magazine* revealed an unprecedented comparison showdown involving 12 leading detectors—



Large elliptical horn antenna detects radar from all sides, even when approaching hills and curves.

some with prices as high as \$200.

Monitoring straight line detection, the GUL's 9,029 foot range topped the list.

Signals of .01 millionths of a volt are

sufficient to trigger the GUL's scanning alert system (ranging from 9.445 to 24.445 GHz). It successfully detects all police radar—including the new KR-11 short pulse.

What's more, the GUL has a nondirectional antenna; its large elliptical horn pulls in signals from front, side and rear. This 360° detection field maximizes sensitivity, providing you with valuable warnings—even when approaching hills and curves. *CB Magazine's* comparison bears this out: In a K band test for around-the-curve sensitivity, the GUL's detection range was double that of the Fuzzbuster and Super Snooper. And nearly three times greater than the highly regarded Whistler. On X band pickup from the side and from behind, it was found to be the most effective detector in the dozen.

Doesn't cry "wolf."

The most common problem among radar detectors is the failure to screen out false signals, such as signals from taxis and ham radios, as well as hospital microwaves.

But the GUL shows no sign of faltering when exposed to radio signals of any kind. Its sophisticated circuitry is completely shielded by a diecast and extruded aluminum case which protects

the input terminals from stray signals (the most common cause of false alarms). The aluminum provides lightness, along with durability not found in plastic casings.

A double warning system.

Both a tone and light come on in the presence of radar, and remain on until radar is gone. You're never lulled into a false sense of security by a tone that sounds once and then goes off. You control the tone with a front-mounted on/off switch.

In addition, the GUL uses an internal voltage regulator, commutating filter, and synchronous detector to reduce power consumption to a minimum. This also provides a more stable gain setting. And its gain control knob lets you optimize sensitivity for different city and country conditions.

Quick installation.

The compact GUL measures only 4" x 3" x 4½". It weighs just 20 oz. Its case is finished in glare-free matte black, and comes with bracket in place.

To mount, simply fasten the adhesive Velcro pad to the top of your dashboard; a matching Velcro foot (on bracket) keeps the unit securely anchored. This

Velcro mounting allows for easy removal in seconds to prevent theft (the unit is even small enough to be stowed in any glove compartment). To supply power, simply plug it into your cigarette lighter.

Try it yourself.

Order the GUL Micro Scan today. Road test it for yourself. If you don't find it to be the finest electronic counter-intelligence you can own, return it within two weeks

for a courteous refund. The Sharper Image guarantees your satisfaction. Comes with complete instructions and 120 day warranty.

ORDER NOW TOLL-FREE.

Please order product #131. Credit card holders may use our toll-free number below. Or send check for \$95 plus \$2.50 delivery. In California, add \$6.17 sales tax.

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In California 800 622-0733

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PS READERS TALK BACK

Address letters for this column to: Readers Talk Back, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

Flying flywheels?

Enjoyed Susan Renner-Smith's articles on energy-storing flywheels [PS, Oct. '79 and Jan. '80] very much, though I must confess Pierre Mion's October cover painting sent snakes up my spine when I considered that two-ton flywheel spinning at 15,000 rpm being suddenly subjected to even a small seismic disturbance—say, one of those little rolling tilts so common in southern California.

Has anyone estimated the size of the resultant crater? The necessary 100 percent containment would appear very difficult.

William S. Battis, Alsea, Ore.

Susan Renner-Smith replies: "Dr. Alan Millner of MIT, developer of the 'base-ment flywheel,' points out that it would be sitting on a soft magnetic suspension that could adjust to movements of the flywheel. Thus it would take quite a tilt to move it. In general, the flywheel is designed to be able to sustain anything the house can. And the flywheel is in a concrete pit; even if it breaks, it can't get out. Remember, we're talking about fiber composites that shred rather than fragment."

First X-ray telescope?

In your article "Orbiting Observatories" [PS, Feb.], you say, "HEAO-2 has the first and only imaging X-ray telescope orbited."

That is not the case. I worked for a couple of years on an X-ray telescope using grazing-incidence imaging principles. Unfortunately, it no longer exists; it plowed into Australia a few months ago with Skylab.

Bill Scarbrough, San Francisco, Calif.

According to NASA: "HEAO-2 carries the first telescope capable of producing focused images showing the structure of X-ray objects. Previous experiments could only detect the approximate position and intensity of objects."

Perhaps this clarifies what we meant. In the field it is accepted that this telescope is the first one that comes close to matching the resolution of optical telescopes.

Cover the Styrofoam

In his letter "Insulating a Whole-House Fan" ["Readers Talk Back," Feb.], reader E. C. Bauer tells of constructing an insulating cover for his whole-house fan out of two-inch Styrofoam.

A caution is in order, since uncovered Styrofoam is a fire hazard and its fumes are toxic. Most building codes require that when Styrofoam is used as a building material, at least a half inch of fireproof material be used over it. Drywall or plaster is usually used as the covering.

William Westcott, Cleveland Hts., Ohio

"Nola's Power Saver" in DIY kit

Congratulations to E. F. Lindsley for his fine appraisal of "Nola's Power Saver" [PS, Feb.]. I was sorry, however, that the article omitted the fact that my company, M.H. Marks Enterprises, is the only supplier of the Power Factor Controller in build-yourself kit form.

For the past several months, we have been selling and shipping the Electra-Miser Power Factor Controller to control fractional horsepower motors in a complete kit for \$32.95, plus \$3 postage and handling. Furthermore, we expect to manufacture a completely assembled version by early spring.

Myles H. Marks, M.H. Marks Enterprises
Thornberry Ct., Pittsburgh, Pa.

Reel-type mowers

Your article "Mowers for 1980" [PS, March] does not mention any reel-type mowers. I am a firm believer that for lawn maintenance, the reel-type mower is best.

I own two such mowers, and my lawn looks much cleaner and more uniform than my neighbors' after mowing. Rotary

mowers must always run with high engine rpm, and that's brutal to grass.

Reel types are safer, quieter, and actually cut the grass.

Ralph Y. Akimoto, Mineral Wells, Tex.

E. F. Lindsley replies: "I agree with all you say about the cutting quality of reel mowers. The problem is that a nicely fitted reel and cutter bar costs far more to make than a single whirling blade. And the reel mower won't handle really shaggy lawns, rough stuff, and the humpty-bumpty conditions typical of most lawns. If you top-dress and keep your lawn in persnickety condition, they're fine."

"Moreover, anyone with a rudimentary grinder can clean up the battered edges on a rotary blade. A reel mower requires professional equipment and a trained operator. That's expensive and few of us want to be bothered."

Yea for Breslin

Bill Hawkins' article, "Breslin—The Home Computer That Runs My House," [PS, Jan.] was very interesting and funny. I don't think I've laughed so much since I read Bob Gannon's story, "Only One Wheel to a Customer" [PS, June '67]. I'd like to see more articles with humor in PS.

Daniel Palmer, East Hampton, Conn.

Bill Hawkins replies: "Thanks, my mom liked it too."

Different wings—different things

I read with interest the article about "Wrong-Way Wings" [PS, April] for future aircraft. However, nothing was ever mentioned about all the years of tests performed on the scissors-wing concept. It would seem that if a forward-swept wing is so much better, then an aircraft with a forward-swept wing on one side and an aft-swept wing on the other is in trouble.

Jerry Green
Frankfort, Ind.

Ben Kocivar replies: "The scissors-wing concept [PS, Oct. '78] is primarily designed for transonic transport or passenger craft. The forward-swept wing is conceived for a highly maneuverable aircraft that would produce very high G-forces and would be unbearably uncomfortable for ordinary airline passengers."

Correction: In "The Liberated House" [PS, April], an incorrect address is given for the supplier of the gray-water recycling equipment. The correct address is Water Equipment Technologies, 4255 Westroads Dr., W. Palm Beach, Fla. 33407. [PS]

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CALCU-LETTER

By DARRELL HUFF News of pocket calculators—and how to have fun with them

Watching your dollars grow

In this dizzy world of inflation and accompanying economic complexities, your pocket calculator can do a lot to keep your thinking in order. For one thing, it can tell you your real rate of return on an investment. And you don't need a specialized business or investment model, either.

You can find basic rate-of-return figures quickly with any calculator. Just divide the amount your account has increased during the period by the sum you started the period with. Then multiply by the number of periods there are in a year. Now you can compare this annual rate with alternative investments or bank accounts.

Stop! There's something wrong with this method, even though it describes a usual practice. Do you see where we went astray?

What's wrong is that it doesn't take into account a shifting base. Each quarter you're getting interest on an increased amount of money. To change a compounded quarterly rate to an annual rate, it is not sufficient just to multiply by four. The correct procedure is to add 1 to the quarterly rate expressed as a decimal, then multiply this sum by itself three times (that is, raise it to the fourth power), subtract the 1, and move the decimal point back two places to the right.

Try one for size

I have before me a quarterly report from a mutual fund in which I have a Keogh retirement plan. It says that I have 1562.417 shares with a current value of \$7.28 each. The previous report three months ago put my holding at 1530.876 shares, then valued at \$7.11. I haven't withdrawn or add-

ed funds to the account, other than automatically reinvesting the dividends.

Applying the two routines above, run these figures through your calculator and see if you agree that I have, for the moment, an investment yielding 19.25 percent on an annual basis—right in step with the current inflation rate, which is more than can be said for most investments.

Before I receive a mound of mail from entranced investors, let me hastily point out that this figure is for one quarter only, and is not guaranteed to make anyone rich. In some other recent periods this same investment has not done nearly so well.

Constant-memory TI's

You may have noted that it is just as you're about to complete an important calculation that the phone rings. Dinner call always comes just as you're halfway through a complex program or have your checkbook almost balanced. With either of these models from Texas Instruments, though, you just shut off the machine and forget about it. Five minutes or five weeks later—when you return to the problem—all the figures you were working with will be waiting for you in the display and memories.

TI offers what it calls Constant Memory on its middle-priced scientific and commercial models. The impressive \$25 Slimline TI-35 (top) is a 54-function slide-rule type with all the expected trig, log, and powers keys—and factorials and statistical capabilities to boot. The ultrathin BusinessCard (bottom), at \$40, has keys for such things as compound interest and profit margin. Both have LCD displays good for some 1500 hours of use with a



pair of miniature batteries. And, if you forget to turn one of these off, it will do that by itself after a few minutes.

Any root with any calculator

You can derive *any* root with the routine given in the January "Calcu-letter" for finding cube roots on a calculator that doesn't have a special key for roots and powers. I'm sorry there isn't space here to list all the readers who recognized this and proved it with their calculators. They all suggest using essentially the same Newtonian method.

Whether or not you have any need to use this surprisingly efficient algorithm, I think you'll find it an amusing exercise for honing your calculator skills. For one thing, it demonstrates how a scientific calculator—which, for all its remarkable results, really doesn't know how to do much except add and subtract—goes about deriving roots. Using this routine to refresh myself on the manipulation of an HP-19C programmable, I found I used 17 steps. By adding eight steps I was able to program it to do its own tests of results, and stop automatically when it had the root.

Here's the routine: To find the *n*th root of *M*, begin with a guess. (Things move a little faster if you make a good guess, but it's not necessary to do so.) Raise this guess to the *n*-1 power and divide *M* by this. Multiply the guess by *n*-1 and add this. Divide by *n*. Using this result as a new guess, repeat the procedure. Continue until you get the same result twice.

Those pregnant dice

Gambler's dice that helped give birth to the branches of mathematics called probability and statistics came up in the May "Calcu-letter." You and your calculator were challenged to confirm that the Chevalier de Méré stood to come out ahead betting even money he'd get a six at least once in four rolls of a single die.

Problems of this kind are toughies until you get the idea of doing them backward.

Note that since each die has six faces, there are five chances in six of *not* rolling a six. So the probability of failing with all four is $\frac{5}{6}$ to the fourth power, or 48.225 percent. Subtracted from 100, that leaves a 51.775 percent chance of success, which is what won for de Méré.

Our 17th-century adventurer won so much money with that modest edge that he soon ran out of takers. He then switched to offering even money that a double six would turn up at least once in 24 rolls of two dice. With this bet he found he was losing his chemise. Can you figure out why—and how fast?

You might like to start by examining the logic that, in more recent times, led Fat the Butch to lose \$49,000 betting The Brain he could do it in a mere 21 rolls. John Scarne, in *Scarne's Guide to Casino Gambling*, says Fat figured that if one roll in 36 is a double six he'd have an even chance with 18 rolls—and 21 would give him a safe and profitable margin. In the September "Calcu-letter" we'll take a further look at de Méré's downfall and Fat's fiasco.

PS calculator columnist Darrell Huff (P.O. Box AS, Carmel, Calif. 93921) is the author of *How to Lie with Statistics*, *How to Take a Chance*, and other works. He welcomes comments, solutions, and suggestions.

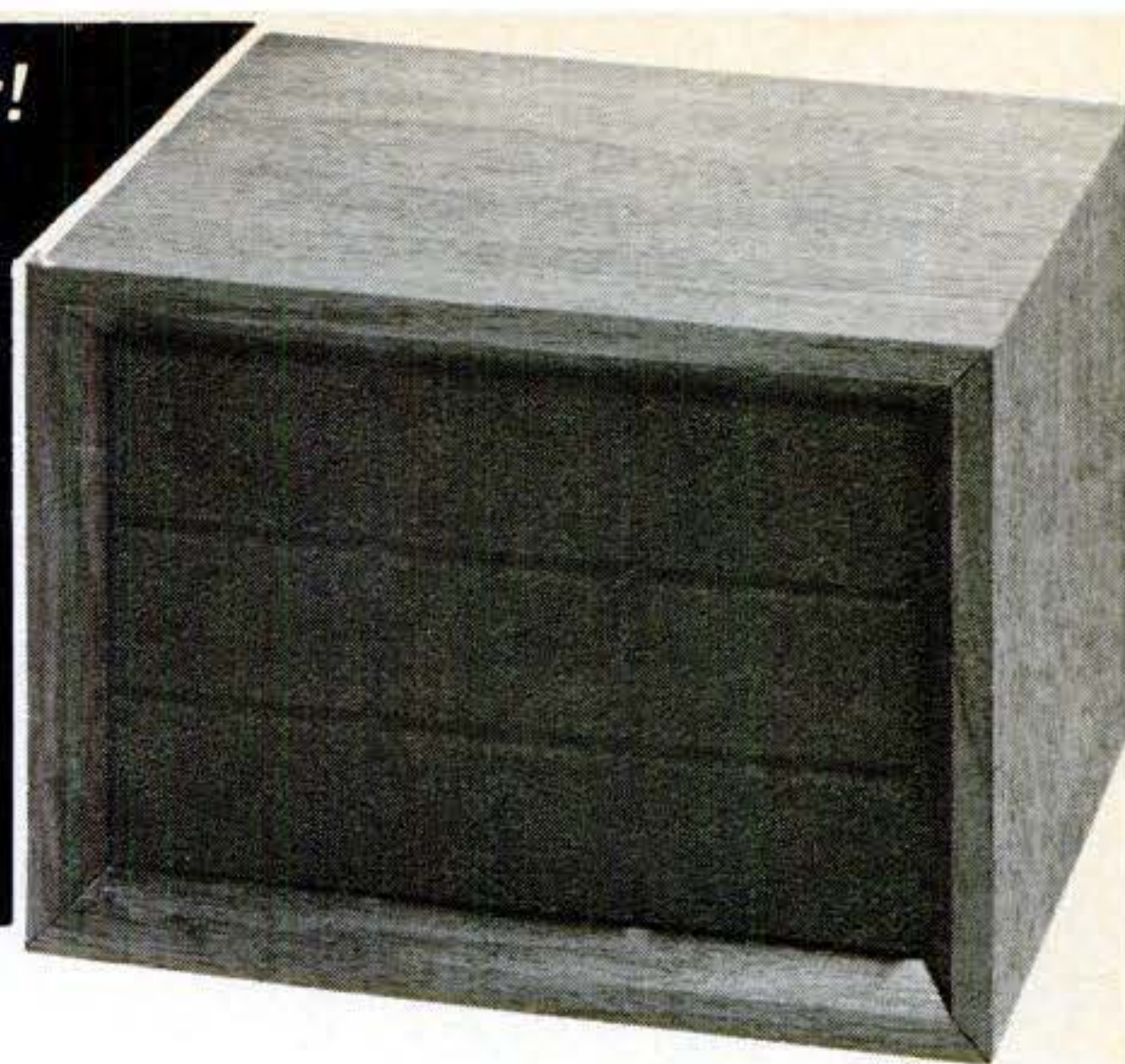
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Protects Every Square Inch Of Your Building

Turns On Lights Automatically

Powerful Electronic Siren



Low Cost Computerized Burglar Alarm System Home - Office - Business

The Guardex 8000 Alarm System is walnut grained and disguised to look like a small stereo speaker (6 3/4" x 9 3/4" x 8") and weighs less than 6 1/2 pounds.

NO INSTALLATION

Just plug the Guardex 8000 alarm system in, make several simple control adjustments to suit your particular building and it works! There are no other wires to run. This totally self-contained burglar alarm can completely seal off every square inch of the surface of your building. It protects doors, windows, and what most alarms miss... your roof, walls and floors.

HOW CAN ONE SMALL COMPUTER PROTECT MY WHOLE BUILDING?

Guardex 8000 Alarm System works on the principle of audio discrimination. This, put simply, is the process of electronically separating normal everyday sounds, such as voices, telephones, etc. from break-in type noises such as breaking glass, prying metal, or forcing a door open. The Guardex 8000 protects one story homes and offices up to 2000 square feet and open commercial buildings up to 10,000 square feet. The Guardex 9300 with wireless remote sensor capability is available for multi-story homes and offices or single story with more than 2000 square feet. Call the factory for more detailed information.

TURNS ON LIGHTS AUTOMATICALLY

When the first break-in type sound is detected, the system will instantly turn on lights, radio, or other electronic equipment that you have plugged into the back of the alarm. These lights or other equipment will remain on for a period of five minutes, then automatically turn off.

POWERFUL ELECTRONIC SIREN

The Guardex 8000 alarm is equipped with a loud built-in siren. If during the five minute period the lights or other electronic equipment has been activated, a second break-in sound is detected, (it can be only a second or two after the first break-in sound) the built-in siren will start blasting for 90 seconds. At the end of approximately 90 seconds the siren will shut off and the alarm listens again. If another break-in sound is heard, the siren will come on for another 90 seconds. If no other break-in sound is detected, the siren will stay off and at the end of the five minute period the lights will shut off and the alarm instantly resets.



The rear control panel contains two standard AC plug receptacles for a table lamp, spot lights, radio, etc.; terminals for connecting optional outside siren and back-up battery (not included); entry delay time control and sensitivity control.

EXIT AND ENTRY DELAY

The Guardex 8000 alarm has a built-in exit delay allowing you approximately one minute to lock up and leave the building before the alarm is armed. When you enter your building you may find that just your normal entering sounds activate the siren. You may delay it from starting for up to 30 seconds by turning up the siren entry delay control.

BATTERY BACK-UP

Burglars rarely cut power. However, to give you total protection from a burglar and possible power failure, our alarm has provisions for a battery back-up. (Batteries not included). 12 volt lantern batteries are available at most hardware stores.

THE BURGLARY PROBLEM

The F.B.I. statistics show that at the present rate, one out of every four Americans are going to be burglarized. That is not a very pleasant fact, but it is true. You have a greater chance of being burglarized than being a victim of a fire or automobile accident. The time is now to help protect yourself and your valuables with a Guardex 8000 alarm system.

OUTSIDE SIREN

The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from the main alarm, they are available with 50 feet of wire for \$24.95. (Connecting terminals are provided on the back of the alarm).

30 DAY NO RISK TRIAL

This is your opportunity to purchase an alarm system directly from the factory for only \$199.95. Try it in your home or business for thirty days without risking one cent. Put our Guardex 8000 alarm to your own test. See for yourself! It will protect every window and door from break-in. If you are not completely satisfied, return the alarm within 30 days for a complete refund. To order your Guardex 8000 alarm, CALL TOLL FREE to charge your credit card or send your check to Guardian Electronics, Inc. in the amount of \$199.95. If you want the optional outside siren, add \$24.94. (California residents add 6% sales tax.)

(If you require more information, call during California business hours, Monday - Friday)



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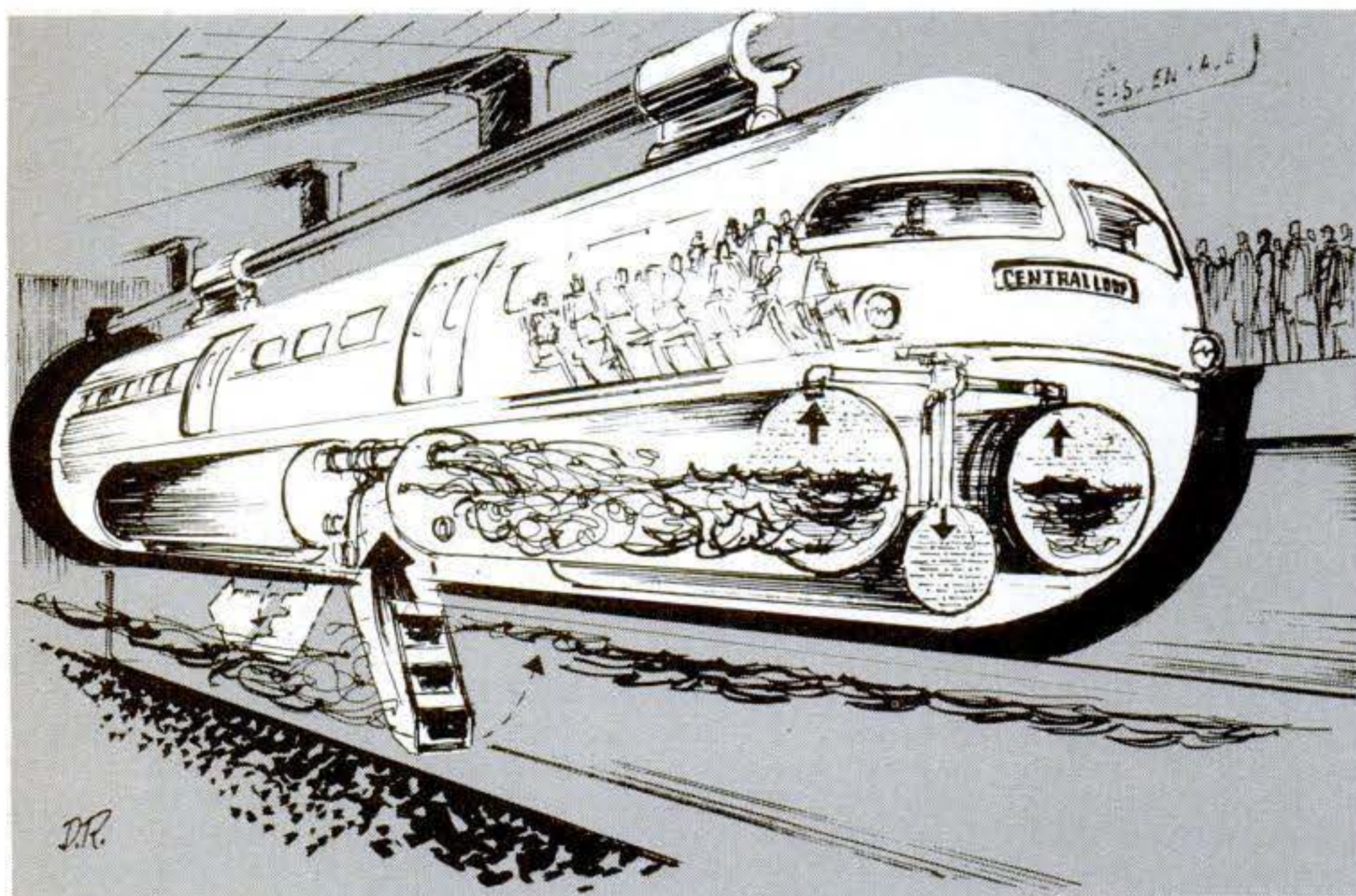
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Westlake Village, Calif. 91361

NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY DANA RASMUSSEN



Tube train recovers braking energy for acceleration

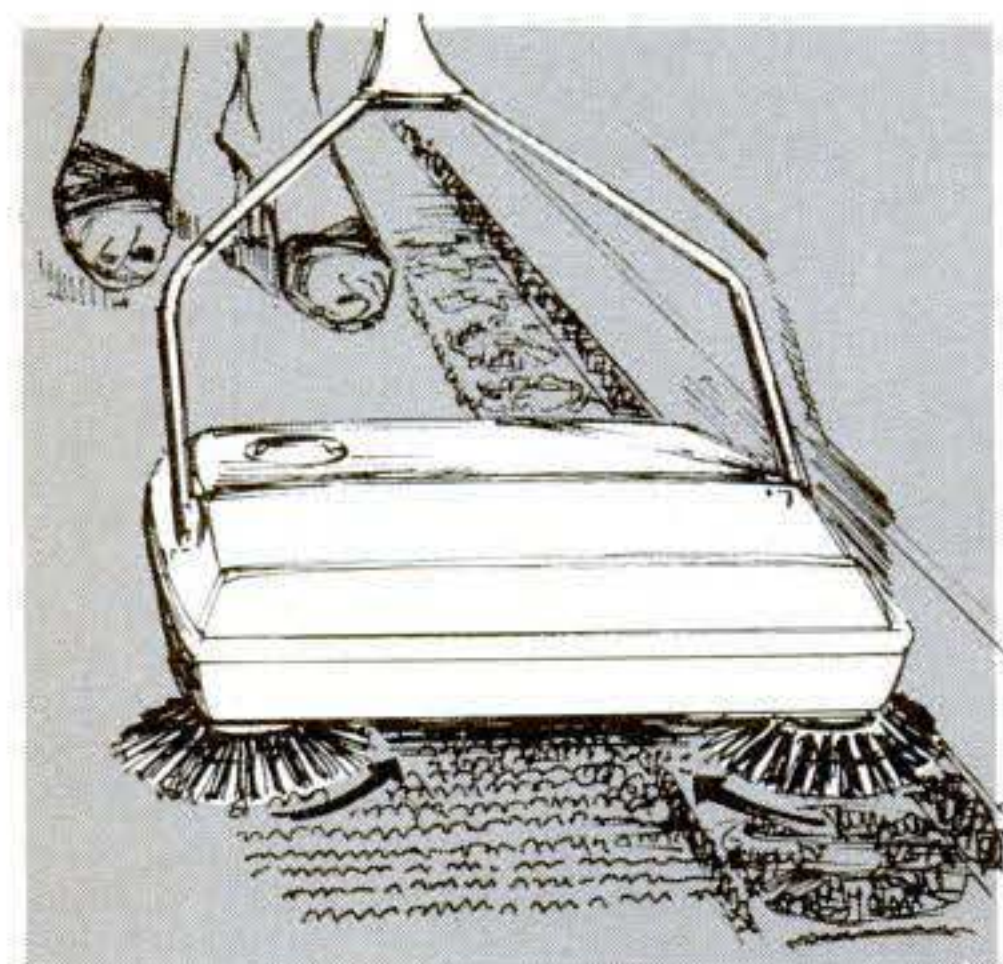
Tracked to ride in the upper part of a tube or circular tunnel, this train would be accelerated by stationary magnetic engines or water-jet propulsion. As it neared a station, a set of braking scoops would be lowered into the water-filled trough of the

enclosing tube. Water entering the tubes would be collected under ram pressure, then expelled to accelerate the train to its next stop. This regenerative fluid braking, it's said, would reduce energy consumption, speed traffic with faster starts.



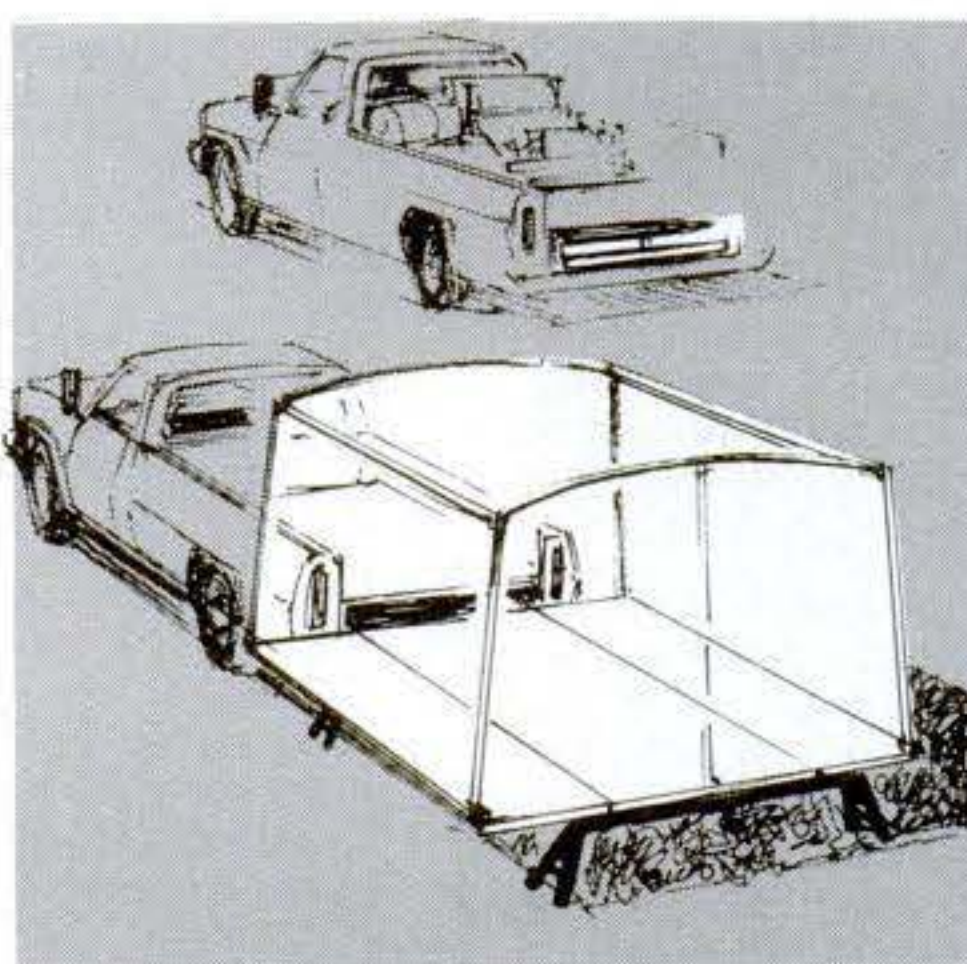
Pool float sounds alarm

A float-lifted, normally closed magnetic switch, mounted at a swimming pool's waterline, would sound an alarm when lapping water opened the circuit—as might be caused by a child jumping or falling into an unattended pool. Another, normally open switch would also trigger an alarm if the device was lifted out or tampered with—a trick that might be attempted by intruders.



Sweeper reaches into corners

Rotating on an axis leaning slightly off the vertical, each of these circular brushes would reach both under and beyond the skirt of a carpet sweeper. Radially extending carpet-gripping teeth on the undersides would cause the brushes to turn as you rolled the sweeper back and forth, thus raising—and capturing—near-the-wall dirt that most cleaners can't reach.



Tent extends from pickup

Stored under a false floor laid into the bed of a pickup truck, these hinged, light-weight panels would slide out to form both base and frame support for a roomy, off-the-ground, attached or free-standing tent. When stored, it would allow normal use of the pickup's cargo space. Said to be as convenient as a shell tent, it would give much more sleeping space.



Beeper displays number

Instead of just letting you know that someone is trying to reach you by phone, this pocket beeper would display the calling party's number while he was still on the line. You could then signal back that the message has been received, or you could call back directly from any phone without having to check in first with your office or answering service.

The following patents have been issued on these inventions: **Regenerative brake**—No. 4,108,077 to N. Laing, Aldingen bei Stuttgart, Germany; **Corner sweeper**—No. 4,107,809 to R. Schuelein, Singhofen, and R. Friedrich, Nassau, Lahn, Germany; **Pickup tent**—No. 4,109,954 to R. Wall, Phoenix, Ariz.; **Pool alarm**—No. 4,069,405 to R. Fima, Addison, Ill.; **Beep-**

er—No. 4,172,969 to A. Levine and B. Haskell, Chevy Chase, Md. Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

NEW PRODUCT

Sports Radar^{T.M.}



Here's how an exciting new micro-electronic breakthrough will make your children heroes and improve your tennis game.

Just point the gun and read the results.

When Roger started pitching for his little league team, he was just another player. And his arm was no better than anybody else's.

Two months later a small miracle took place. Roger was the best pitcher on the team and had a fast ball that was the most powerful in his league—and all thanks to his father.

Roger's success came from a radar gun—the same type device used by police to catch speeding motorists.

SCRAMBLED EGGS

The minute Roger's father was able to clock his son's pitching speed, Roger was subconsciously given a daily challenge of pitching harder and faster to beat his previous speed. The more he practiced, the better he got.

Roger's father paid \$2,000 for the radar gun. But in his upper class neighborhood, it wasn't too unusual for a father to spend that kind of money to help his son.

SPEEDING CITATION

A large manufacturer of radar-type security devices saw what Roger's father had done and felt that there was a definite need to produce a low cost radar unit designed exclusively for the sports market.

The company, Solfan Systems, developed the Sports Radar gun—a major breakthrough in projectile speed detection as well as electronic radar circuitry.

Using the doppler effect of radar and phased-lock-loop circuits, Solfan has developed the Sports Radar gun that compares to even the most sophisticated of police radar units that cost \$2,000.

OVERLAND EXPRESS

The Sports Radar gun is held in your hand and pointed toward the pitcher. You turn it on, press the ready button, and point the gun. The gun will ignore the moving arm of the pitcher but will lock in on the moving ball. The radar unit would then follow the ball for approximately ten milliseconds and the built in computer measures and computes the speed and flashes the reading on the display. The gun registers the speed to the exact mileage within one-half miles per hour.

The gun can be mounted on a tripod so that the person taking the measurements can also catch the ball.

In tennis, the speed of the serve can be measured by aiming the gun at the person serving. You can also use the unit by yourself by setting the unit on a tripod and measuring the speed from behind.

WORKING AND PLAYING

Aside from its extreme accuracy and advanced electronics, the unit is priced to meet the budget of every sports-minded athlete or parent. It's only \$189.95 complete.

You can measure the speed of baseballs, soccer balls, tennis balls, golf balls, hockey pucks, downhill skiers, radio controlled model airplanes or anything that moves—even automobiles.



The speed is flashed on the large LED display and is shown in miles per hour.

The unit accepts two commercially available 6-volt lantern batteries which you can purchase locally or from JS&A for only \$2 each. The batteries will last for weeks with normal use.

SUCCESS AND GOOD THINGS

The unit comes in a sports blue color and weighs 38.4 ounces, exclusive of batteries. It's rugged, well built and designed to endure the typical use and abuse it would normally receive.

We urge you to test this exciting new product during our 30-day free trial. Order the Sports Radar gun. When you receive it, measure your child's pitching speed. Test it on your own tennis serve. See how knowing your speed will actually improve it as you try to out perform your previous record fast pitch or serve. Then decide if the Sports Radar gun doesn't make a very exciting addition to your sports equipment.

ONE FOR THE MONEY

If you are not convinced that the Sports Radar gun is something that you'll use constantly to help improve your game, return it for a prompt and courteous refund, including your \$3.50 postage and handling. You can't lose—and chances are your son will at least have the most popular new product in the neighborhood.

To order one for your test, simply send your check for **\$189.95** plus \$3.50 for postage and handling to JS&A Group, Inc., at the address shown below. (Illinois residents please add 5% sales tax.) Credit card buyers may call our toll-free number below. If you wish to buy a set of two six-volt batteries, simply add \$4.00 to your order.

We'll then send your unit, the batteries (if you order them from us), a 90-day limited warranty and complete easy-to-understand instructions.

Radar electronics for the sports enthusiast is now a reality. Watch your game improve by ordering your Sports Radar gun at no obligation, today.

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ALTERNATE-ENERGY ANSWERS

By JAN F. KREIDER

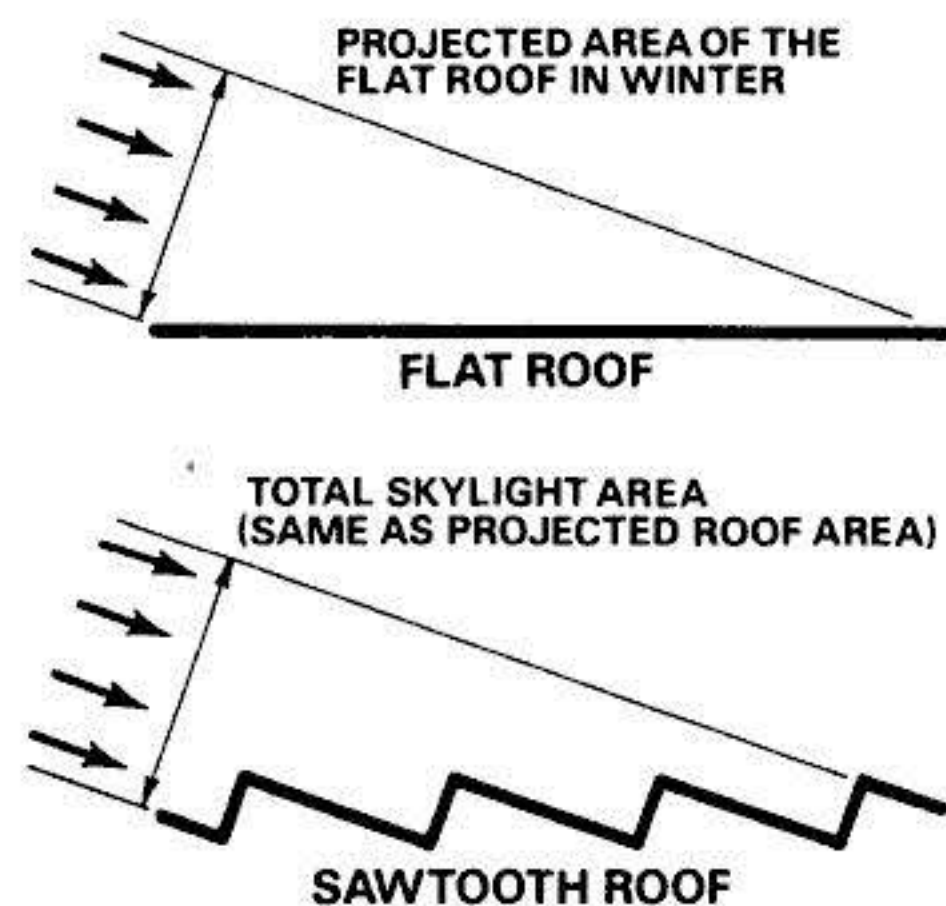
Jan F. Kreider is a consulting engineer specializing in the design and economic analysis of solar-energy and energy-conservation systems. He is the author of several books on solar technology, and a lecturer at the Univ. of Colorado.

Roofing a pool

I am going to enclose our swimming pool. I plan to use saw-tooth roof framing so south-facing windows would pass the sun's heat rays to heat the pool. A flat roof would be simpler to build. Would it pass more solar heat?

Dale Watt, Tulsa, Okla.

A flat roof will pass more heat in summer (when you don't need it) but less in winter. The sketch shows that the projected area that the sun "sees" in winter is the same for either a saw-tooth or flat roof. However, the low angle of the winter sun on the flat roof will cause much greater reflection of sunlight than would occur from the saw-tooth, which faces the winter sun directly. The sawtooth design will block the



high summer sun and keep the pool area from overheating. Also to be considered, however: A flat roof is not only simpler but less expensive to build.

The old flue hole

I've used the "old flue hole" method of isolating the antifreeze loop in my thermosiphon solar water-heating system. The thermosiphon works fine: I'm getting 130 degrees F and more water than I can use in June, July, and August, but performance falls off in September and the system does poorly in winter. My collectors are tilted at 35°, which is way off from my locality's ideal latitude—plus 15° or 57°. Is this the reason for the poor performance?

V. Richardson, Sunderland, Mass.

The "flue-hole" heat exchanger (made by welding steel discs with 3/4- or one-inch-dia. nipples to the top and bottom of the flue in an ordinary gas-fired water heater, and piping the heat-transfer fluid through the flue) can transfer some heat from a

thermosiphon system to a storage tank without constricting the flow, but the heat-exchange area available is relatively small—the flue is typically only four to six inches in diameter. Since the heat transfer from the flue-hole surface to the water in the tank is by natural convection, the rate of heat transfer is low, thereby forcing the collector to operate at a relatively high temperature. And the hotter a solar collector operates to provide heat to a given demand, the less efficient it will be. Your collector tilt is not the reason for poor performance in the fall and winter.

The flue-hole method has other problems: (1) It will not meet codes that require two separation walls between glycol antifreeze solutions and potable water; and (2) the flue hole will corrode and leak if a copper solar collector is used. Like many other solar ideas, the flue-hole concept will work to some extent. The questions are: How long, how reliably, how safely, and how effectively.

Passive storage

I plan to use rocks for space-heating storage for my passive-solar house. What is the ratio of rock storage volume to window area for such a system? I've managed with no oil for three winters now and have used four to five cords of wood. I keep windows open in the day to release excess heat but would much rather store heat during the day.

Roland Lauze, Lovell, Me.

We plan to build a passive-solar two-story house with a large Trombe wall (13 by 34 ft.) on the south side. Our first choice for storage was a large number of water-filled plastic containers in the crawl space. We would like carpeting on the floor but are afraid this would provide too much insulation.

Donald Johnson, Briston, Ill.

Rock storage is effective when used properly with a passive-solar system. It is more effective and easier to fabricate than water-bottle storage. The amount of storage used is 3/4—one cubic foot per square foot of passive-collector area. Rock storage can only be filled effectively with heat, however, if a small fan is used to force warm air through the storage bed. This warm air flows from a high point in the solar-heated space, through the bed, and back to a low return point in the solar space. A typical airflow rate is two cfm/ft² of passive glazing area.

The location of storage is important. If positioned behind a wall or beneath the floor, comfort in the interior space near these areas will be improved. Heat flow from the heat-storage bed to the space is

relatively slow. Results from a carefully studied house in New Mexico, however, indicate that about one-third of the total solar heating occurred from heat stored in the rock bed. The wall between the storage bed and the living space should be uninsulated, of course.

Wood heating system

In order to take full advantage of my wood heat source, I wonder if it is feasible to have pipes embedded in the floor slab. A radiator would be built into the fireplace and a pump would carry a liquid to disperse the heat throughout the slab. With a fire burning during the day, the slab should act as a reservoir, providing heat throughout the night.

Dean Lange, Denver, Colo.

Yours is typical of a number of questions regarding fireplace heat-recovery systems using water. Their design is more of an art than a science at this time. The key things to consider are: (1) achieving adequate heat-transfer surface area of the tubes without blocking the natural fireplace draft; (2) removing heat from the tubes quickly enough to prevent boiling (this can cause your pump to cavitate); (3) selecting proper materials for the system, bearing in mind galvanic corrosion and possible high-temperature periods if a pump should fail; and (4) designing proper safety devices including an expansion tank and pressure-relief valves.

Predicting the heat flow from the flames to the heat-recovery tubes to size your pump is very complicated. I suggest that you build the device, light a hot fire, and run water through it with a garden hose at a rate that will give the temperature rise you want (keep this temperature well below boiling). Then measure the flow rate with a bucket and stopwatch. A pressure gauge attached to the water inlet will tell you what the pump head should be. Heat storage in your floor slab should work well.

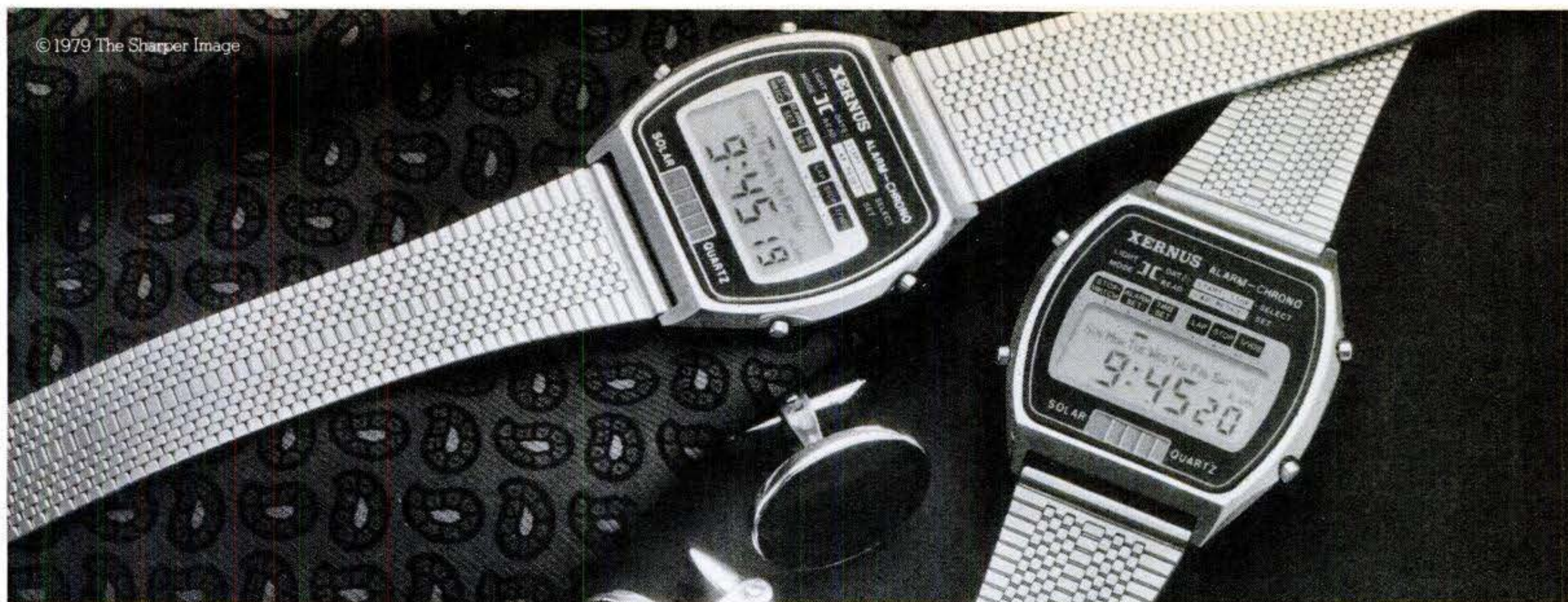
Solar information

Could you recommend a reference that will give specifications for designing and constructing flat-plate collectors, storage, and automatic delivery systems?

Garland Bergh, Plainview, Neb.

The best source of such information is the National Solar Heating and Cooling Information Center. The toll-free number is (800) 523-2929. Ask for free reference lists on the topics you mention. Another source of information is the Solar Energy Research Institute in Golden, Colo. Phone: (303) 234-7171.

Got a question on an alternate energy such as solar, wind, water, or wood? Or on energy-conservation techniques that could reduce your home's heating and cooling costs? Every other month, alternating with "Adventures in Alternate Energy," Jan Kreider answers questions selected from those sent in by readers. Write to "Energy Questions," POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Queries can't be answered by mail.



ENDED AT LAST. MAN'S 400-YEAR STRUGGLE TO MAKE A WATCH THIS SMART, THIS THIN.

Timekeepers first appeared on people's wrists shortly after the development of the mainspring; approximately 1540.

The geniuses of invention have worked to trim the size and bulk of the wristwatch, ever since.

Last year, in fact, Seiko set a record for flatness with a 2.5 millimeter quartz watch; it sold for \$5000. Yet for this unearthly sum, its owners could learn only the hours and the minutes of the day. Not a stitch more.

History has been made again. Now with an electronic liquid crystal quartz timepiece that approaches the thinness—but greatly exceeds the talent of Seiko's pride.

Its name is Xernus (pronounced *zer' nus*). And The Sharper Image brings it to you through the mail at the highly tempting price of just \$89.

Normal time mode. Continuous display of hours, minutes, seconds, day of week. With alarm indicator.

Date at the flick of a button. Shown in large, crisp digits. Automatic end-of-month adjustment.

24-hour alarm. Speed setting to the exact minute, AM or PM. High-volume electronic beep, auto reset.

Precision stopwatch. 12-hour timing to 1/10 second. Laps, 1-2 finishes, time-outs.

Easy night reading. Face light illuminates display on command.

Nobody else in America offers Xernus; if and when they do, it will most certainly be priced at \$150 or more.

The world's slimmest solar alarm chronograph.

How trim is this brainy piece of jewelry—that gives you the time with ± 15 seconds a month accuracy, the day and date, an alarm, a stopwatch and a solar-assisted battery—squeezed into a wafer?

Precisely 4.95 millimeters from the top of its mineral glass crystal to the back of its solid stainless steel case. (Xernus functions are further described in the face diagrams, below.)

Before you pick up your phone, we invite you to compare the thinness of Xernus to the world's remaining crop of solar alarm chronographs.

Seiko, an undisputed leader, sells a comparably talented timepiece for \$250; it measures 10.5 millimeters from top to bottom.

In the Under-\$150-League, competition for slimmness in alarm chronographs is even more dismal. Texas Instruments' is 12.0 millimeters thick; the Advance, 9.5 millimeters. And these are some of the thinnest.

Craftsmanship that's rare at even \$150 more.

Both case and bracelet of Xernus are machined from solid stainless steel, not plated base metal or "silvertone" (a material that pits and peels, often after only a few weeks of light use).

Once again, the face isn't scratch-prone plastic, but rock-hard tempered mineral glass.

And the manufacturer of Xernus is one of the few who dare to even mention water-resistance. Better yet, they guarantee your Xernus against water damage to 60 feet below the surface. (They're conservative; it has proven to survive in 90.)

Other Xernus distinctions? Mirrored face plating; a highly difficult technique that's just now beginning to

frame the displays on only the most costly digitals. A tightly meshed, smoothly polished bracelet that doesn't pull at skin or hair. Recessed function buttons that stay out of your way.

This unusual timekeeper is available to you in two different models: all Stainless or Gold (with a rich 5 microns worth over stainless). Incidentally, that's real gold, not "goldtone".

Xernus comes with full instructions, service-by-mail, if needed, a one-year manufacturer's guarantee against defects, and its battery in place. (Sensitive to sunlight or even dim roomlight, Xernus solar cells will keep this micro-thin battery working for up to 2 years. Replacements are available at most jewelers.)

And best of all, you have the chance to see a Xernus perform right on your wrist—before making your final commitment.

Keep it for two weeks. And if for any reason you decide not to be a Xernus owner, simply send it back (in new condition, please). And The Sharper Image will return your entire investment without question. Including the delivery charge.

Time is of the essence. Please order now, as stock is limited at this price.

ORDER TOLL FREE.

Credit card holders may use our toll-free number. Or send check for \$89 for Stainless, \$109 for Gold (in CA, add \$5.34 and \$6.54 sales tax, respectively.) Plus \$2.50 delivery. Ask for product #942 (Stainless), or #138 (Gold). For our 40-page color catalog, write address below.

800 227-3436
In California 800 622-0733

THE SHARPER IMAGE™
260 California St.
San Francisco, CA 94111 (415) 788-8880



Travellin' Fridges

Beat inflation! Space age breakthrough eliminates coolers and ice.

ORDER NOW IN TIME FOR YOUR HOLIDAY.

You've nicely gotten away on your long awaited vacation, camping trip or long weekend with the family. You're comfortably cruising in your car, van or rec. vehicle along a busy interstate with few rest stops or restaurants. You guessed it... the kids want to stop for a snack. But your Koolatron P34 or P34A is full of sandwiches, cold pop, fried chicken... home made, fresh and cold. The family helps themselves and you've saved valuable vacation time and another expensive restaurant bill.

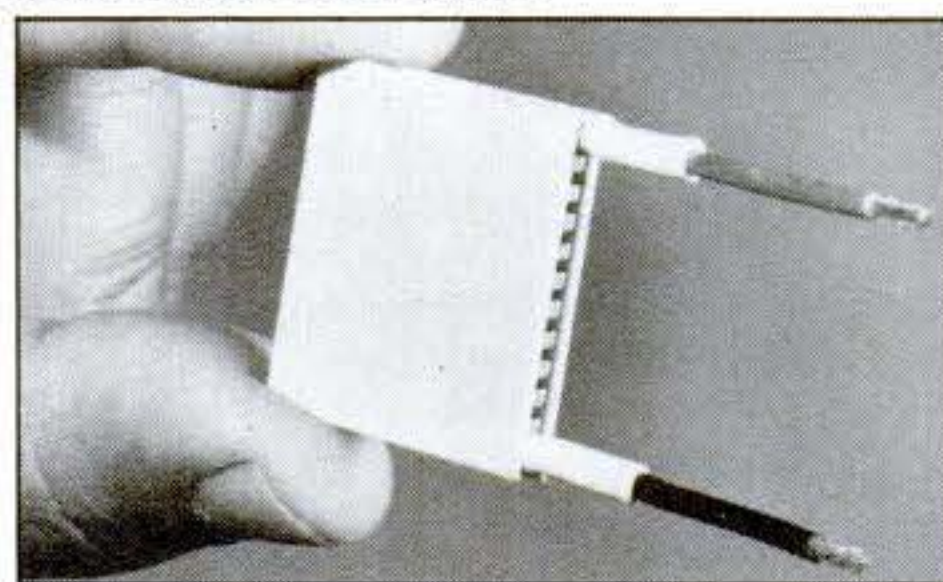
You're a commuter, a salesman or a trucker and you spend many hours in your vehicle daily. You've often longed for a fresh snack or cold beverage as the miles tick away. Now with your amazing Koolatron P10 plugged in beside you, you open the lid and instantly fresh food and drinks are at your fingertips. You're refreshed... you've saved an unnecessary stop, time and money.

AFFORDABLE CONVENIENCE

Home refrigeration has come a long way since the days of the ice box and the block of ice. But most of us resign ourselves to doing without the same convenience once we leave our homes. Or, we revert back to the cooler and ice routine of days gone by, simply because there's never been any dependable and inexpensive alternative. But now, for the price of a good cooler and one or two seasons of buying ice, (or about 10 family restaurant meals), all the marvels of home refrigeration are available electronically. And the sloppy

ice cooler with its soggy and spoiled food can become a stone-age memory for you. An amazing space-age miracle... the thermo-electric solid state module... makes this portable refrigeration revolution possible.

AEROSPACE MODULES



Two of these miniaturized thermoelectric modules replace all the bulky complex piping coils, compressors and motors in conventional portable refrigerators.

Utilized by NASA scientists, as the only refrigeration system for rockets and satellites, thermo-electric cooling has been in use for almost a quarter century. These expensive modules were selected by NASA for some basic reasons... they're small (about the size of your watch)... they're light weight (2 of them weigh less than a package of cigarettes)... they're totally reliable (these modules are completely solid state and have no moving parts)... they require little power (2 modules use the same power as one of your car's tail-lights)... they're completely insensitive to

tilting, bumping, vibration, (which causes failures to conventional compressors, motors and piping)... they're powerful (2 modules have the same cooling power as a 10 lb. block of ice)... and they never wear out or break down. And for portable refrigeration where you require 12 volt DC. power, thermo-electric modules are the most efficient. These amazing heat pumps have not only gone to the moon, but have provided the breakthrough for Koolatron's truly reliable, lightweight portable refrigerators.

THOUSANDS IN USE

Koolatron Industries Limited now has tens of thousands of these electronic fridges in use worldwide using these same powerful solid state modules. The reliability, performance and convenience of electronic refrigeration has now been dramatically tested and proven in all kinds of temperatures, conditions and environments from Australia to Alaska. Built to take it, two of these electronic modules are encased in tough, plastic insulated chests that are designed to be rugged and trouble-free. Non-rusting hinges and latches prevent corrosion in salt water environments. And with only one moving part (a small 12 volt fan) Koolatron portables seldom see a service depot. Koolatron's combination of space-age heat pumps and quality engineering have now led to a whole family of electronic portable refrigerators and food warmers that eliminate costly ice and provide "home refrigeration" convenience at sane and sensible prices.

**MODEL P10 -
THE PERFECT CAR FRIDGE
& FOOD WARMER**

\$129.00
(in Canada
\$139.00)



Holds approx. 17, 12oz. pop cans - refrigerates in air temps. up to 95°F. Also keeps hot foods hot (150°F.) at the flick of a switch. Deep rich blue Polypro plastic case. Ext. 16" L x 11" H x 11 1/2" W. Int. 11 1/2" L x 8" H x 8" W. with 10 litre capacity (0.4 cu. ft.) weighs 10 lbs. empty. Operates from supplied 12 volt power cord in vehicles or with optional 12VDC/110VAC power adaptor.

Koolatron's P10 not only makes a great car fridge but at a flick of a switch lets you bring home your favourite fast foods "piping hot". Comes with a 9 ft. power cord that just plugs into your cigarette lighter. Amazingly easy to operate ... one switch selects hot or cold. A second switch allows you to refrigerate normally or select maximum cold. With your engine off, you can operate for up to 6 hours and still start your engine. "A low battery" indicator warns you when it's time to recharge. With the power off, your P10 keeps everything hot or cold for many hours in its well insulated case.

As a travel fridge the P10 keeps your favourite foods and beverages fresh and cold wherever you go. If you're a salesman, your food samples will arrive perfectly hot or cold every time. If you carry insulin, medical samples, dietetic foods, your P10 will never leave your side. Great for private planes.

Photographers will find it invaluable for keeping expensive films from going bad. And mothers ... now you can refrigerate baby's formula in your car then heat it with the flick of a switch or keep it cold. Powerboaters, just plug it into your boat's cigarette lighter, and keep a day's food and drink ice cold without running into shore for ice. You campers, hunters and fishermen will find endless uses for transporting provisions and bait ... then take home your catches and game without spoiling. Terrific for golf carts.

And with our optional 110 volt adaptor you'll find endless uses wherever house current is available ... At your cottage ... as a bar fridge ... in your motel room for a midnight snack and drink ... as a small office fridge ... or beside your pool. Use as an auxiliary home fridge when you're having a party. And it's a natural at drive-in movies, auto races and at sporting events.

**MODEL P34 -
THE PERFECT
RECREATIONAL FRIDGE**

\$169.00
(in Canada
\$179.00)



Holds over 40 lbs. of food and beverages or 48 pop cans. Refrigerates in air temperatures up to 95°F. Rugged ABS case in sand beige colour with dark brown non-corroding latches and handle. Large 34 litre capacity (1.2 cu. ft.) weighs 17 lbs. empty. Ext. 21" L x 16" H x 16" W. Int. 16" L x 12" H x 11 1/2" W. Operates on 12 volts DC with supplied power cord or with optional 12VDC/110VAC power adaptor.

The P34 is the full-size member of the Koolatron family of portable electronic fridges. It is designed especially for the serious traveler and outdoorsman. Newly designed for the 80's, this handsome improved portable will refrigerate more than 3 times the contents of the P10. As a hunter, camper, boater, you'll be amazed at the capacity and convenience.

Imagine dry, dependable refrigeration with the size to match your travelling and camping needs. Fits into any boat, van or camper or back seat of your car. Plugs into your cigarette lighter receptacle and refrigerates over 40 lbs. of food (no space wasted by ice), yet it draws no more power than the P10. With our optional 110 volt adaptor, you'll find endless uses as a bar fridge, cottage fridge, office fridge. Dazzle your friends at your next pool party with a full pay load of cold ones right beside the pool. Your P34 has all the advantages of the P10 without the heating cycle or low battery indicator but with all the capacity needed for serious boaters, campers, hunters, fishermen and travellers.

**MODEL P34A -
THE ULTIMATE RECREATIONAL
REFRIGERATOR &
FOOD WARMER**

\$189.00
(in Canada \$199.00)



The same size, colour, weight and capacity as the P34 but includes food warming features, fully adjustable temperature control and low battery warning indicator.

The P34A is our top of the line portable. It heats, it refrigerates and with specially designed electronic circuit control (patent applied for) it allows you to dial a complete range of temperatures from very cold to very warm.

READ WHAT OUR CUSTOMERS SAY:

"We took meat from Canada and ate it ten days later after thawing it in Florida. All our produce and drinks stayed unbelievably fresh and cool." SH., Hamilton, Canada

"The way I try to sell my refrigerator one would think I was on commission. We love our unit!" P.O.P., Houston, Texas

"I am so pleased with the fridge I don't know how we got along before - it's so easy - to carry, use, maintain. For such a relatively small cost the convenience is inestimable." K.R., C'tawa, Canada

"The Koolatron is everything they say about it in its advertising. I personally bought one, tested it and found it so desirable that I gave it to my daughter and son-in-law who made a cross-country trek from Vermont to Oregon with their infant daughter. They told me that aside from their new Dodge van, the Koolatron was the most indispensable item of equipment they carried." K.M., New York, N.Y.

You wine buffs will find it indispensable to chill up to 1 doz. wine bottles at just the right temperature. Low battery indicator warns you when you need a recharge and the sensing circuits efficiently control your power consumption to save on battery drain. This is our best of the line, recreational fridge and food warmer with all the bells and whistles for the discerning buyer who demands quality, size and complete versatility.

ORDER TODAY WITHOUT OBLIGATION!

Simply complete the attached order form or phone collect and we'll rush you your portable on our no risk 21 day trial offer. Each unit comes with complete instructions and a written 1 year warranty. In the unlikely event you ever need service, we have major service centres in New York, Arizona and Canada. When you receive your Koolatron, use it constantly for 3 full weeks without risk.

If you ordered our optional 110 volt adaptor, plug it in, then use your portable immediately as a bar fridge or around the patio or pool. Next plug it into your car or RV. Take your family out for a weekend trip. Enjoy fresh home cooked food as you thumb your nose at those expensive restaurant stops. Then use it on your boat or in your office or let your son or daughter try it at their college dorm. If after you've thoroughly tested it, you don't agree that your Koolatron represents a major breakthrough that will save you time, money and bother for years to come, send it back for a full refund. You can't lose ... we guarantee it.

So be among the thousands to discover that the ice age is over! Don't waste another dollar on ice ... order your Koolatron with no obligation, today!

For rush delivery phone your order in collect to

0-705-737-0842

Koolatron Industries Limited
56 Harvester Ave., Batavia, New York 14020
230 Bayview Drive, Barrie, Ontario, Canada

Or use this handy order coupon.

Koolatron

Dept. 1202

Industries Limited

56 Harvester Avenue, Batavia, New York 14020
Canada: 230 Bayview Drive, Barrie, Ontario L4N 4Y8

Send me with full refund privileges:

- ___ Koolatron P10 at \$129.00 (\$139.00 in Canada)
- ___ Koolatron P34 at \$169.00 (\$179.00 in Canada)
- ___ Koolatron P34A at \$189.00 (\$199.00 in Canada)
- ___ Koolatron 110V adaptor at \$29.95 (\$34.95 in Canada)

Please add \$8.00 for handling and delivery per unit.

No charge for shipping adaptor if ordered with unit.

Add \$3.00 for shipping adaptor only.

(N.Y., Ont. and Quebec residents add sales tax.)

I understand that I may return any item undamaged within 21 days and receive a full refund if I am not satisfied.

☐ I enclose my check or money order for

\$ _____ or please charge it to my

☐ Visa ☐ Mastercharge ☐ American Express

Account Number _____

Expiry Date _____ ☐ Send brochure only.

Signature _____
(necessary to send merchandise)

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- DON 1 -

VW Jetta

— Rabbit with a trunk

That's Jetta, for jet stream: Volkswagen's newest entry in the U.S. is aptly named, as I discovered when I put a two-door version through its paces on the Maryland shore. VW's first U.S. hatchback has tight, precise handling, thanks to rack-and-pinion steering and a standard anti-roll bar on the rear axle. In Europe, where engines up to 110 hp are available, front and rear anti-roll bars are standard. Acceleration through the standard five gears is more than adequate. Fifth, however, is best for long-distance highway cruising; I downshifted to fourth to pass.

On a 250-mile trip, mostly on toll roads at a steady 55 mph, I found the Jetta a reliable and steady performer. Even in heavy sidewinds, the car held steady. Seats are comfortable and visibility is good. The AM/FM stereo radio (a standard feature in the Jetta) helps to pass the time as the car cruises effortlessly.

Jettas are powered by a 76-hp, 1588-cc fuel-injection four-cylinder



engine. The EPA rates the Jetta's city mileage at 25 and estimates that you'll get 40 mpg on the highway. An optional three-speed automatic gets 22 mpg in town and 31 mpg on the open road.

Aside from plusher trim and quad rectangular headlights, the big difference between Jetta and the Rabbit is Jetta's trunk. It's a whopper: 13 cubic feet.

A VW spokesman told me that a two-door Jetta, equipped with a five-speed transmission and other standard equipment, would list at \$7650. A four-door model, with automatic transmission, sunroof, air conditioning, and alloy wheels would cost \$9500.—R. L. Stepler



New from Stewart-Warner

Mini-Panel

The world's smallest instrument panel alerts you to car problems before they cause costly damage.

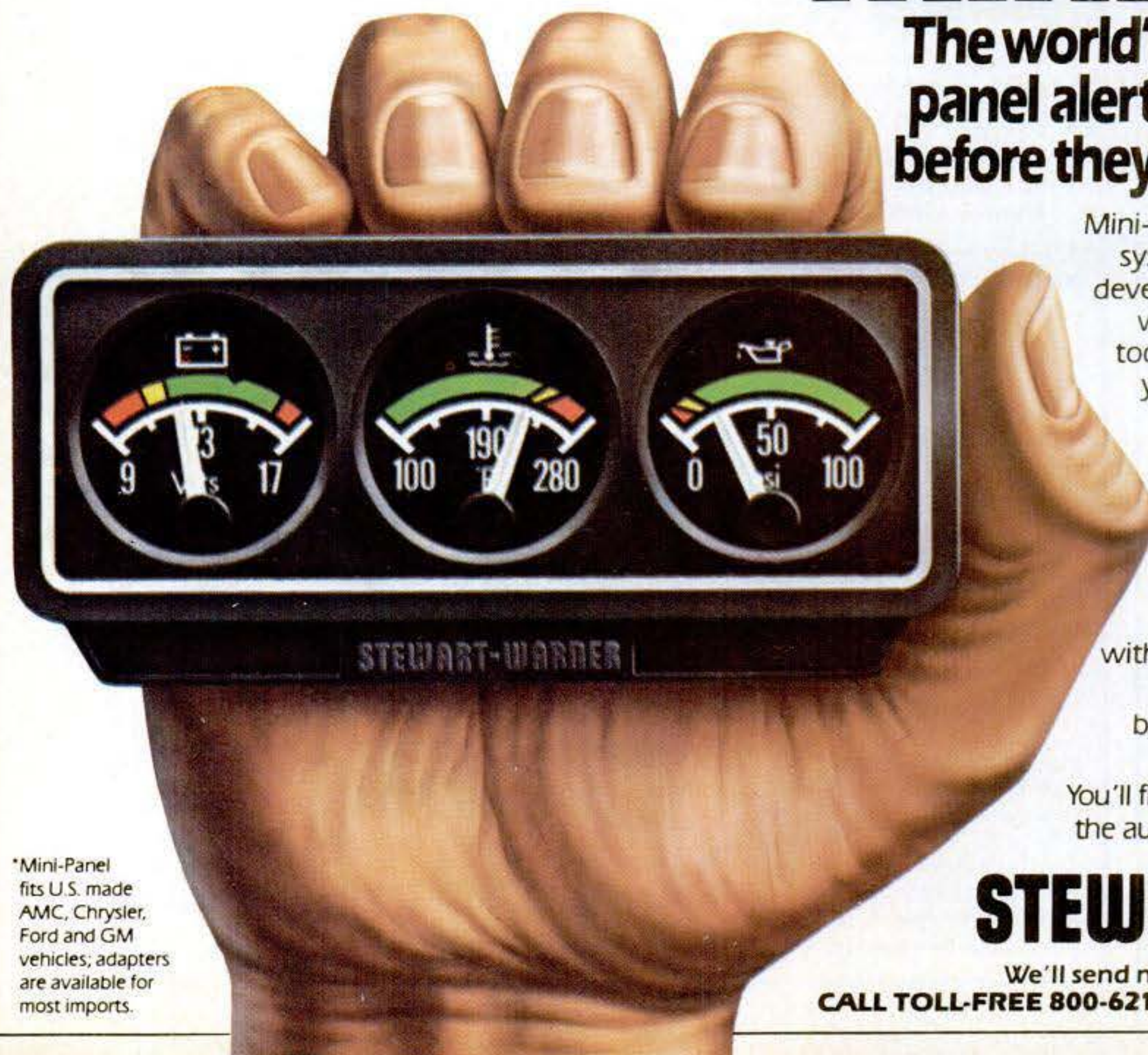
Mini-Panel is the miniaturized early warning system that helps you spot problems that develop while you drive. (Unlike traditional warning lights that don't go on until it's too late.) Catch those problems early, and you'll save yourself a lot of grief, as well as expense.

Each gauge serves an important function, enabling you to monitor electrical, cooling, and oil pressure systems at a glance.

Mini-Panel is so compact you can mount it on top of your dashboard—without obstructing your view of the road.

It's easy to install* with no drilling or bolting. No unsightly wires, so you have a professional-looking installation.

You'll find Mini-Panel at auto supply stores and the automotive section of leading retail stores.



*Mini-Panel fits U.S. made AMC, Chrysler, Ford and GM vehicles; adapters are available for most imports.

STEWART-WARNER SYMBOL OF EXCELLENCE

We'll send name and address of your nearest dealer,
CALL TOLL-FREE 800-621-5199. IN ILLINOIS 800-972-5855.

Get out of the rat race with your own TV or audio service business.

NRI will train you at home to service TV, audio equipment, video recorders, car stereo and more. Then show you how to run your own full- or part-time business.

Why stay stuck in a dead-end job when you can build your own future? You can learn to be a TV, audio and video technician right at home in your spare time. Get the training you need for a new career without quitting your job or traveling to and from night school. NRI makes it happen with exciting career training in TV and audio servicing.

Build TV, stereo, professional instruments

NRI training is practical training. Along with easy-to-digest theory in "bite-size" lessons, you get plenty of actual "hands-on" experience as you build our Master Course's big 25" computer-controlled color TV that lets you program a whole evening's entertainment, AM/FM solid-state stereo with speakers, transistorized volt-ohm meter, 5" triggered-sweep oscilloscope, TV color pattern generator, CMOS frequency



You get all this professional equipment, build this 25" (diagonal) computer-programmed TV as you learn.



Start in your garage or basement and watch your business grow.



Be an audio specialist servicing home and auto stereo.

counter, and perform meaningful experiments with them and the NRI Discovery Lab.®

Business training as well as technical training

Of course, NRI training gets you ready to enter this field at many levels. You can start by working for an established service company, a dealer, or a manufacturer. But you can start working for yourself, too. NRI lessons show you how to set up and run a full- or part-time business. You learn job costs and billing, even how to set up a complete accounting system. That's how complete the program is.

The pros select NRI training

More than a million students later, NRI is still first choice. A national survey (summary on request) shows that more than half of practicing TV technicians have had home study training, and



Get into the booming video tape recorder market.

among them, it's NRI 3 to 1 over any other school.

You can't beat the value. All in one course you get *both* color TV and audio training, *plus* video cassette and disc systems. Send for our free catalog to see it all.

Free catalog... No salesman will call.

Our big, 100-page catalog has all the facts. Descriptions of every course, each lesson and experiment, pictures and specifications of all the equipment you get. Send for it today, no salesman will ever bother you. If the postage-paid card has been removed, write to:



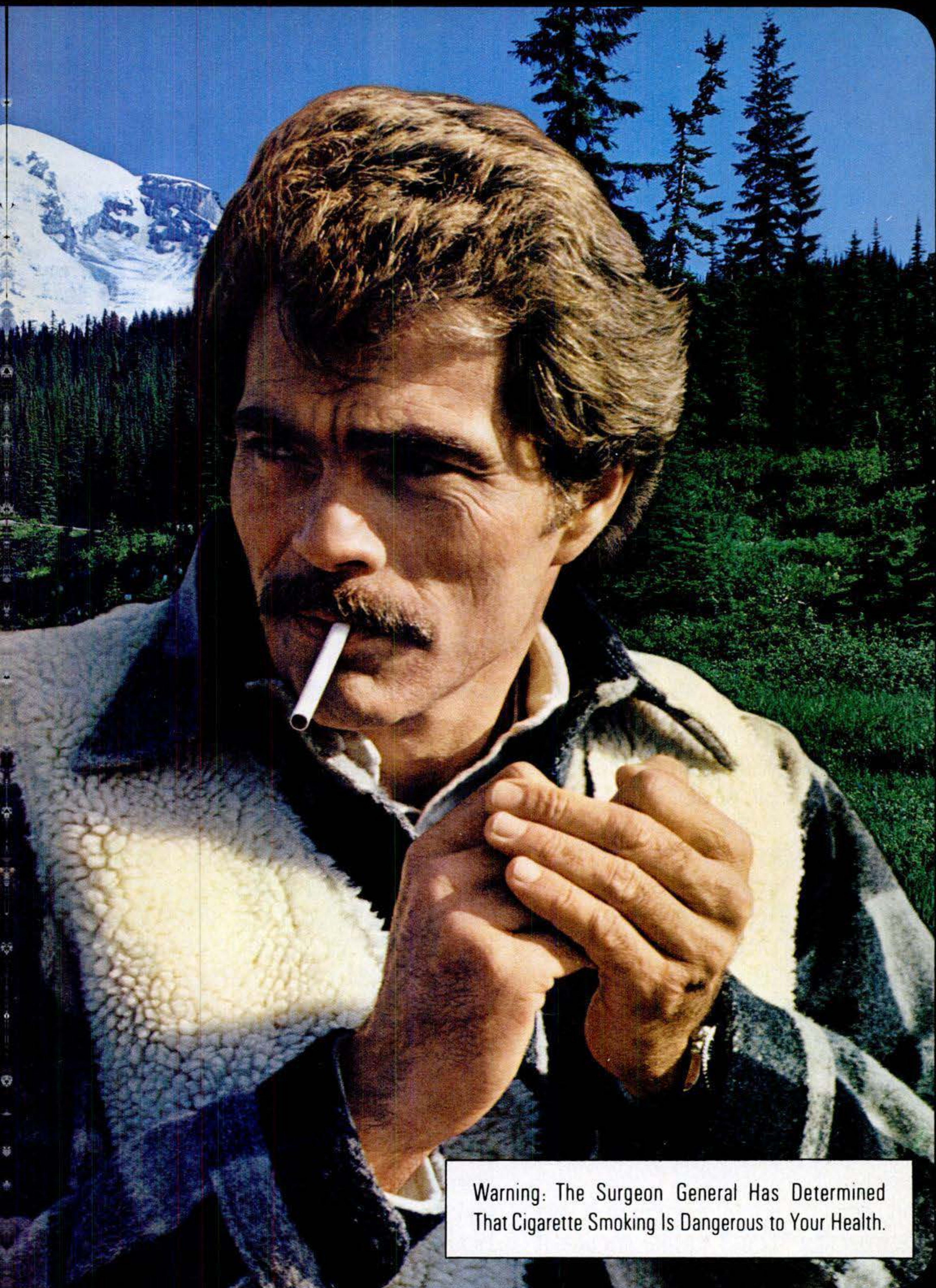
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Taste country fresh Salem

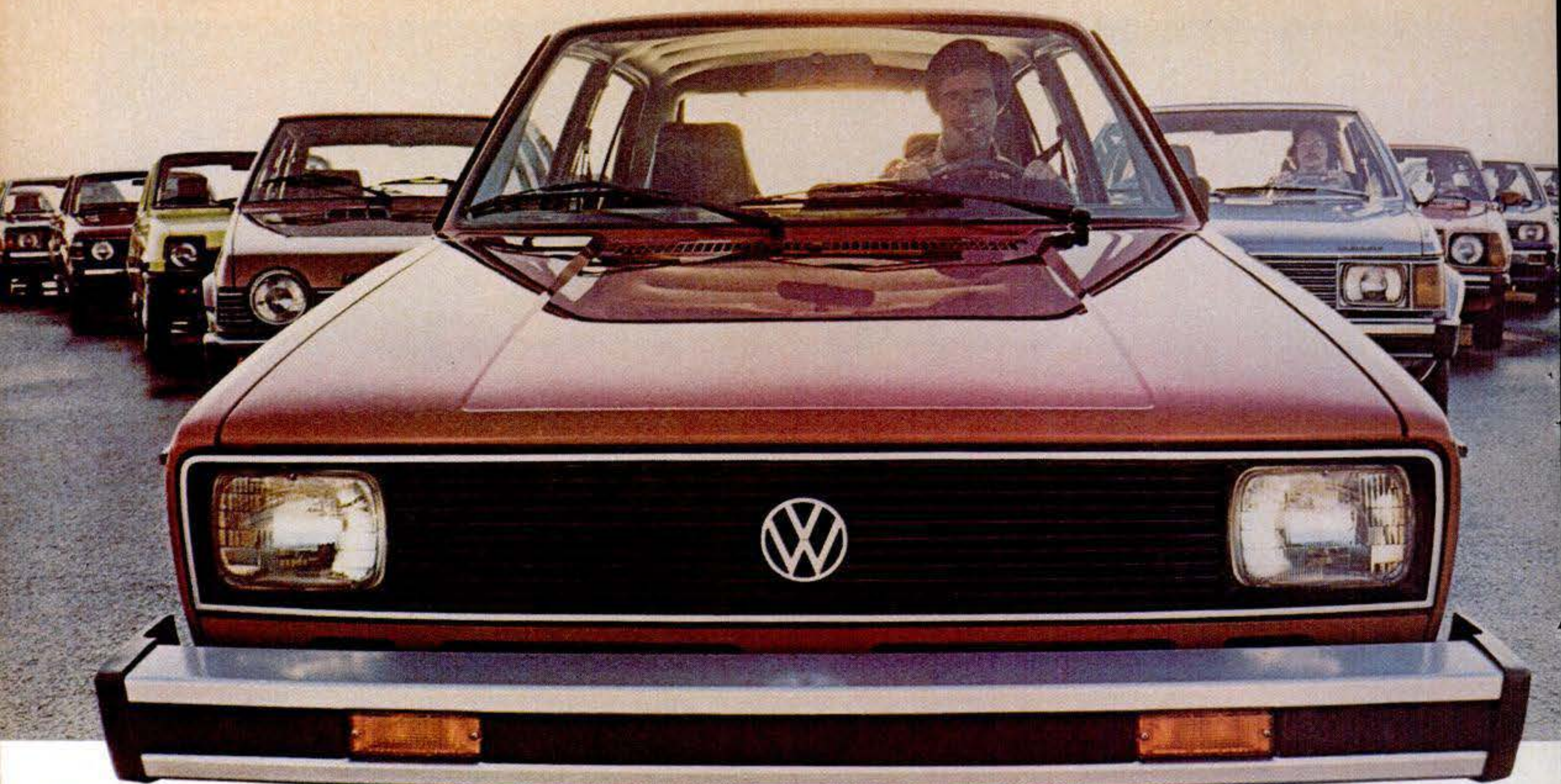


**Light mountain breezes.
Clear, rippling waters. And
country fresh Salem menthol.
That's satisfaction.**

KING: 16 mg. "tar", 1.1 mg. nicotine, 100's: 20 mg. "tar", 1.4 mg. nicotine, av. per cigarette, FTC Report DEC. '79.



Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.



EVERYBODY'S PLAYING FOLLOW THE LEADER.

As you've probably noticed, the Volkswagen Rabbit's imitators are multiplying like, well, rabbits.

But copies are copies.

And while others are busily copying the Rabbit's looks, they're also busily complaining about meeting the U.S. Government's 1985 fuel-economy standards.

Volkswagen meets those economy standards today.

And while debate over passive-safety restraint systems drags on, you can buy a Rabbit "L" with a system that meets the 1984 safety requirements today.

In short, cars that try to look like the Rabbit from afar don't quite make it from anear. But then, why should anyone have thought they would?

Quality always tells. In handling. In performance. In the paintwork. In the way things fit.

Car and Driver said that the Rabbit "has a structure that feels as substantial as a Mosler safe."

So before you consider a car that looks like a Rabbit instead of a car that is a Rabbit, remember one thing:

It's one thing for a plastic surgeon

to make Caliope Brattlestreet look like a movie star. But it's

something else to know that you have to snuggle up every night with Caliope Brattlestreet.

**VOLKSWAGEN
DOES IT
AGAIN**



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RECREATION ROUNDUP

By HERBERT SHULDINER



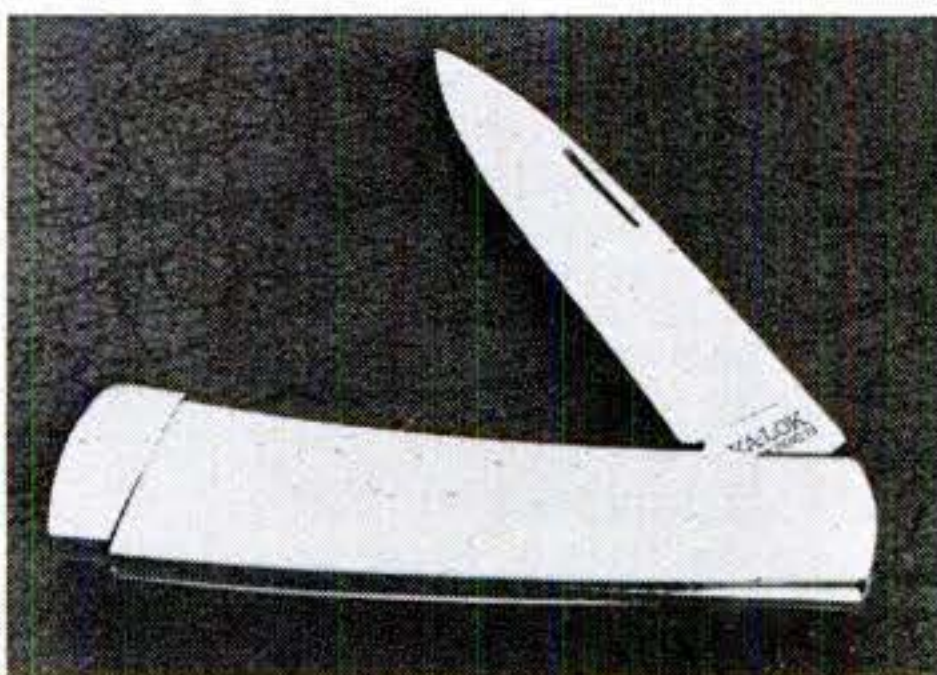
Bright nights for outdoorsmen

A new reflective nylon fabric is now being used to make jogging suits, backpacks, shorts, jackets, and other gear and clothing safer for nocturnal outdoor activities. The Early Warning fabric made by Arthur Kahn, Inc. (444 Park Ave. S., New York, N.Y. 10016), has 3M's Scotchlite reflective finish—microscopic glass spheres that make runners, hikers, and cyclists much more visible at night. Previously, fabric makers have used Scotchlite as trim in other materials. But now, clothing or gear is being made entirely of the material.

The photos of Laguna's jogging suit and Renegade's backpack (above) show that under normal light conditions no visible difference exists between the new fabric and conventional nonreflective types. But at night, the glass spheres reflect lights and make the wearers more visible.

Safer pocketknife

Ka-Bar's Ka-Lok lockback has a new kind of rear bolster-actuated locking mechanism that makes for a sleeker-looking knife. I also find it easier to use than other lockbacks I've tried. When you lift the rear bolster to close the knife, the blade makes



a positive stop before closing so it won't snap on your fingers—an excellent safety feature. Overall length of the Ka-Lok is 3½ inches when closed. It has an ivory-color Micarta handle. Price is \$29.

Economy outboard

Chrysler Marine's new 3.5-hp Economate outboard is designed for small fishing boats, sailboats, canoes, and inflatables. The single-cylinder 32-pound engine has a five-cu.-in. displacement. It has loop charging and a built-in fuel tank with ca-



capacity to provide about an hour's operation. Its top speed is eight mph and it operates at 4000 to 5000 rpm at full throttle. Price: about \$300.

Boating in the U.S.

The National Marine Manufacturers Assn. reports that 58 million Americans went boating at least once last year. The report adds that there are some 11.6 million recreational boats in the country (but only eight million are registered by the Coast Guard). Sixty percent of the boats are under 16 feet long. Included are 6,700,000 outboard boats, 904,000 sailboats, 1,200,000 canoes, and 1,537,000 rowboats. U.S. boatmen spent about \$7.5 billion on their boating pursuits last year, according to the NMMA.

New national park

California's Channel Islands recently became our 40th national park. The Channel Islands include Santa Rosa, Santa Cruz, San Miguel, and Prince Islands, as well as Anacapa and Santa Barbara Islands. The islands contain sea-lion rookeries, brown-pelican nesting areas, and the only breeding colony of northern fur seals south of Alaska. Secretary of the Interior Cecil D. Andrus says the new park will be operated on a low-intensity, limited-entry basis because of its fragile resources. You can get further information by writing the Channel Islands National Park at 1699 Anchors Way Dr., Ventura, Calif. 93003. P 5



THIN SOLAR

12/24-Hour Quartz Alarm Chronograph

Now with fashionably thin styling, long-lasting solar power, 12- or 24-hour selection, alarm and full chronograph.

Featuring:

- Famous Quartz Accuracy to ± 5 Seconds a Month
- Built-in Electronic Calendar
- Night Light for Evening Viewing
- Constant LCD Display
- Day of the Week Indicator
- Easily Adjusted "Snap" Type Bracelet

Thinnest Solar Alarm Chronograph Available at This Low Price!

\$44.88

Solar Power is now combined with remarkably thin styling and famous quartz accuracy in our best selling 12/24-Hour Alarm Chronograph. A combination that Seiko and Citizen can't match, even at \$200 more!

See the value you get for only \$44.88

- **24-Hour Alarm** — Pleasant, but effective, alarm can be preset for any minute of day or night. Constantly read indicator lets you know when it's set.
- **12/24-Hour Selection** — You get conventional 12-hour time or 24-hour military time at the touch of buttons. Switch back and forth as often as you choose. Or, leave it on 12- or 24-hour time for as long as you want. A must for pilots, military personnel or anyone who needs the option of 12 or 24 hour time.
- **Powerful Solar Recharger** — Fully recharges itself even in artificial light. Power that's guaranteed for three full years with life expectancy of many more. No more troublesome battery charges!
- **Full 12-Hour Chronograph** — With 1/10 second precision, add time and lap time. Add time lets you time everything from a telephone call to a trip... up to 12 full hours. Lap time lets you time each component within an event. Ideal for production managers, coaches, sports fans, anyone with a critical time dependent activity.



- Continuously Shows:
- Hours, Minutes and Seconds
- Day of Week Flag
- AM-PM Notation in 12-Hour Mode

- **Quartz Accuracy** — to ± 5 seconds a month.

- **Month, Day and Date** — at the push of a button.



Shown: September 18 Tuesday

COMPARE THINNESS!

Thinnest Solar Alarm Chronograph available at this low price.

Seiko	\$250	10.5 mm
Citizen	\$255	11.0 mm
Texas Instruments	\$125	12.0 mm
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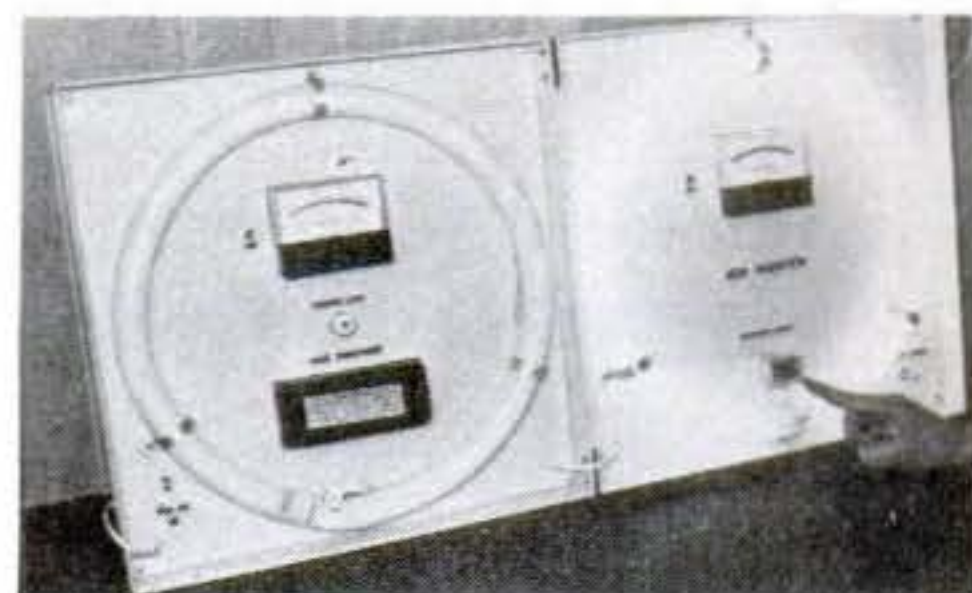
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Energy-saving starter for fluorescent lights



There's a startling difference between the look-alike lights shown above: The one at right uses 20 percent less current. The finger points to the energy-saving secret—a small electronic unit that replaces both starter and bulky ballast. A simple capacitor-discharge, voltage-multiplier circuit supplies the initial voltage surge. This circuit has only two diodes—and no transistors at all. Since the unit is made of only a few, low-cost parts, it is cheaper to make than the conventional ballast and starter. The device gives near-instant ignition with no start-up flickering, says inventor J.N. Kim (Korea Idea Electronics, 301-2 Hyoje-Dong, Jongro-Ku, Seoul, Korea). The electronic unit also eliminates both audible hum and radio/TV interference. A final bonus: The voltage can be cut with a dimmer control to vary light intensity.—David Scott

Clockwork window closer

It's easy to forget an open window—so this timer-type device allows for controlled window ventilation. Opening a hinged window winds up a clockwork-type spring via a string joined to both window frame and motor pulley. An escapement mechanism then releases the motor. With its two-pound pull, the mechanism takes 10 or 12 minutes to close the window, says inventor Gustl Pursch (Holzbachstrasse 4, 8900 Augsburg, Germany).—D. S.



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For years RotorWay's been working hard to change all this and finally it's happened! Oh yes, we're still using piston power, but there's no comparison to the aircraft engine of yesteryear. We designed our power plant to be water cooled, so we can fully enclose it. The RotorWay engine is made of lightweight aluminum and it also has an impressive h.p./weight ratio, but it burns 30% less fuel than most turbines. Since we designed this engine specifically for helicopter use and since its manufactured by us right down to its crankshaft, we had the opportunity to achieve this unparalleled efficiency.

It's not just the power plant that makes the Exec go fast, it's also a fully streamlined teardrop fuselage, coupled with an efficient, sturdy rotor system that has just the right disc loading and solidity ratio for feather smooth flight. Of course, the best news of all is the price. Now you don't need to be president of G.M. to own an executive helicopter. You can hangar the RotorWay Exec in your garage and you won't have to lease it out to pay for it. The Exec won't cost you \$5,000.00 to learn to fly, we'll teach you ourselves since the basic training is included. In addition, local RotorWay Service Centers are now being established to service your helicopter. Send for the RotorWay program evaluation package today.



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DETROIT REPORT

By JIM DUNNE



Buick's mystery car

This prototype is a combination of designs, using a little of the X-body's rear styling, a touch of the 1982 Camaro, and a front end that borrows from the TransAm. It's a proposal car that Buick cobbled up for experimental purposes, but which has no okay for production. Its biggest drawback is its rear-drive chassis, which will be passe in most GM small cars within two years. Buick will have a car of this general type in 1982, when it gets three- and four-door versions of the J-car, GM's replacement for the Monza/Sunbird/Skyhawk/Starfire.

PROCO due in '84

The stratified-charge engine Ford calls its "gasoline diesel" will go into production in 1984, according to present plans. The system will first appear on a small, 300-cu.-in. V8, but will later be adapted to sixes and fours. In the meantime, Ford is undecided about diesel production. No solid plans for a diesel exist, though it is possible one will be produced along with the PROCO (programmed combustion). Asked if the new Escort/Lynx four-cylinder engine is a candidate for the PROCO design, a Ford official told PS, "All our engines are PROCO candidates." The PROCO design uses precise burning, high compression, and high-pressure fuel injection. It is said to get 25 percent better fuel economy than current gasoline types, yet it uses virtually all the same major engine parts.

GM's electric car

General Motors now plans to have an electric car on sale during the 1984 model year, which is at least six months earlier than the original target date. The car will be strictly a commuter type, with two-passenger capacity and short-drive capability. It will look like an electric, too, without

the usual air-intake grille or exhaust pipes of a conventional car. Look for no breakthroughs, however. Top speed will be 50 mph, while driving range on a recharge will be less than 100 miles. These are limits, though, and cannot be combined. At 50 mph, range is cut by more than half. The rechargeable batteries are expected to last 30,000 miles, but then you'll face a big replacement expense.

Lifetime rust protection

If you have your new Ford rustproofed with the Super Seal system at a Ford dealer, you'll get a lifetime repair guarantee. The offer is available only to original owners of new cars, and is restricted to certain parts of the car, including hood, fenders, doors, deck lid, wheel housings, floor pan, and rocker panels. One condition is that you must return every 18 months for a checkup, at no charge. The Super Seal antirust coating costs between \$100 and \$200 a car.

Small Cadillac

GM's luxury-car division will have a small, front-drive, full-size sedan on the market by 1983½. It will use a 108-inch wheelbase and be under 200 inches overall, dimensions similar to Chrysler's proposed 1985 big-car line. V6's will play a big part in the engine lineup, but a 250-cu.-in., fuel-injection V8 will be the top power plant. Look for these cars to weigh less than 3000 pounds and offer the ride smoothness of improved air-spring suspensions.

Ford's code names

Ford is now using the designations Apex and Topaz for 1982½-model projects that will produce a front-drive replacement for the Fairmont/Zephyr twins. This does not mean that the car names will be changed, however, since Ford uses code names for

all its major projects. In the past, it's used Panther for the big Ford/Mercury, Fox for Fairmont/Zephyr, Erika for Escort/Lynx.

Chevy's new names

When the J-car Monza replacement comes on stream next spring, Chevrolet may use Cavalier as its name, and Corsa for a special, sporty three-door model. Meanwhile, in the Citation line, the division will drop the X-11 variant and discontinue the two-door notchback body style for 1981. Another name-change possibility: Commodore for Malibu in 1982.

VW likes diesels

Volkswagen thinks diesel engines are the best bet for its cars to meet the demands for maximum fuel economy in the future. Turbochargers are a necessary part of that plan, and VW has turbo diesels in test for both the Audi and VW lines. The company expects to have a five-cylinder Audi turbo diesel on the street within a year. The diesel Rabbit, which is the current EPA economy leader (42 mpg city, 56 highway) is also a prime target for turbocharging. That would boost performance to the level of the gasoline Rabbit, but still deliver the diesel's high fuel economy under normal driving conditions.

Few V8's ahead

The V6 engine is taking over in cars that have traditionally used V8 engines, but there are still some new V8's in the works. Cadillac has an aluminum V8 planned for 1982, and the Corvette will get a version for 1983. The Cadillac/Corvette unit will be about 250 cu. in., but fuel injection and sophisticated electronic controls will boost power to the level of bigger V8's. The light weight of aluminum makes this possible at a time when the rest of the industry is building smaller engines.

Goodbye, frame-and-body

Frame-and-body construction is now used almost exclusively on American big cars, but the end is in sight, according to two auto makers' plans for the mid and late 1980's. Ford and GM, the frame-and-body experts, are switching to unit-body construction for all of their full-size models of the future. A separate frame underneath makes it easier to filter out road noise before it reaches the car's interior. The switch to unit body could mean a deterioration of the quiet ride that American cars have traditionally delivered. Smaller cars are better suited to unit body, for reasons of lightness and strength.

Who buys a diesel?

A study of Oldsmobile 98 diesel-engine buyers shows that the majority are married men, who are, on the average, about 52, earn between \$30,000 and \$40,000 a year, and who don't mind the \$850 premium for the 350-cu.-in. diesel V8 option on the 98. Professional people dominate the profile and a full 91 percent are men, though the car is also driven by their spouses in the majority of cases. P 5

People write to



Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

How Low Can You Go? I am planning to install an engine oil cooler in a marine 4-cylinder diesel engine. What should the optimum oil temperature be? Is there any danger of the oil temperature being too low?

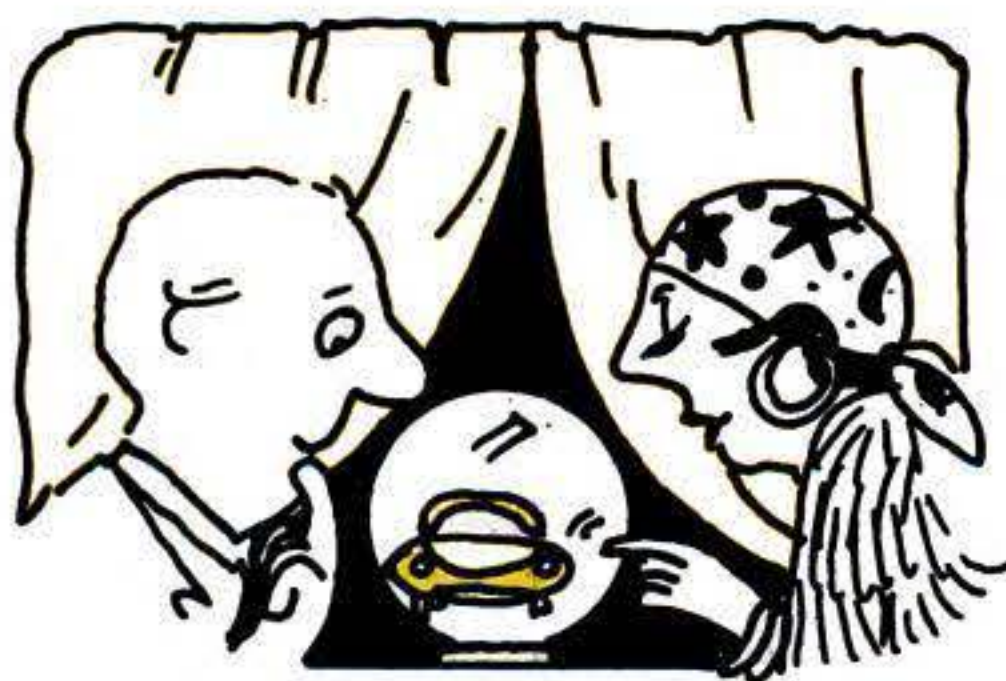
C.J.W., Kailua-Kona, HI

If crankcase oil temperatures are maintained too low, moisture condensation may not be removed when the engine is running. We doubt that this condition would occur even with your oil cooler installed. The crankcase oil, after engine warm-up, should not be lower than 125 °F. A good range for your oil would be between 125 °F.-175 °F. A maximum temperature of 250 °F. for any long period of time should be avoided.

Fanfare. My '72 has 150,000 miles on the engine, and has used no oil but Pennzoil since the day I bought the car. I've never had any major engine repairs, and plan to get yet another 150,000 miles with this engine. Thank you for a truly dependable product.

N.J., Columbia, SC

Thanks for your kind remarks. We at Pennzoil have made a commitment to continue to develop products which exceed the requirements of the automotive manufacturers and their customers. Best of luck for another 150,000 miles of happy driving!



Vette Advice. I have a 1968 Corvette that I no longer wish to drive. I want to keep the car stored in a garage. My main concern is the well-being of the car 5 to 10 years from now. How often should I start the car? How often should I change the oil?

G.T.A., Pearl City, Hawaii

To keep your 1968 Corvette in top mechanical condition, we recommend that

you drive it once a week for a minimum of 10 miles. This will circulate the motor oil, transmission fluid, and differential lubricant over the various engine parts. 10 miles of driving should also remove most of the moisture condensation from the crankcase. You live in a very humid area so moisture condensation may build up quite rapidly. For this reason, and as added insurance, we suggest that you change your motor oil every 3 months.



What's The Story? I'm confused as to Oldsmobile's diesel oil recommendations. Wasn't an SE-CD oil originally recommended for use in this diesel? However, in the 1979 owner's manual for the Olds diesel, an SE-CC oil is recommended. Can you clear this up?

L.C.G., Beverly Hills, CA

For their 1978 Oldsmobile diesel engine, General Motors originally recommended oils meeting SE-CC or SE-CD. A metallurgy problem in service prompted GM to change this recommendation to SE-CD only, which still applies. For the 1979 model engine, however, modifications were made in the valve train so now only an SE-CC oil is recommended.

Moped Mania. I recently purchased a moped that calls for a high quality two-cycle oil at a fuel to oil mixture of 25 to 1. I know that Pennzoil makes several different two-cycle oils including 2-Stroke Motorcycle Oil and Multi-Use 50 to 1 Oil. Which oil would you recommend for use in my moped and why?

R.F.O., Redwood City, CA

For your two-cycle moped engine, we recommend Pennzoil Multi-Use Two-

Cycle 50 to 1 Oil. This oil contains a solvent which enables it to mix more readily with fuel. The 2-Stroke Motorcycle Oil does not contain solvent and is recommended for larger motorcycle engines. Remember that even though the Multi-Use Oil can be used at a 50 to 1 ratio in some engines, you should use it at a 25 to 1 ratio as called for by the manufacturer.

All Systems Go. If you were to break down the components of an automobile into different categories, how would you designate each of them?

C.E.C., Parma, Ohio

An automobile is a series of systems that provide 1) a means to make the vehicle move; 2) a means to stop the vehicle and 3) a means to make the occupants of the vehicle more comfortable. The system which moves the vehicle is called the power train and consists of the engine, transmission, drive shaft, differential and axle. The system which stops the vehicle, the brake system, consists of a master cylinder, brake lines, wheel cylinders and brake shoes. Among the many systems in an automobile present to make the occupants more comfortable are the radio, heater, power steering and air conditioning.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell us a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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SAN DIEGO, CALIF.

Prowling along a winding mountain road, I joined the end of a line of traffic caught behind a laboring farm truck. When we came to a short, clear passing zone, I moved left and punched the accelerator. With surprising ease I was past the impromptu procession and out in the clear.

I was driving a Triumph TR8, the hot, aluminum-V8-powered convertible that is the latest addition to the long Triumph line. If it looks familiar, it should; the heart of the car is the same convertible shell used for the TR7, its four-cylinder little brother.

Fuel injection is standard in California for the car's 3.5-liter (215 cu. in.) engine, but you'll get carburetors elsewhere. A five-speed manual transmission is standard. It is shared with the also-new Rover 3500, along with the engine and final-drive as-

sembly (see Rover story, this issue).

The cockpit is very roomy for a sports car. In fact, if you're of average size and put the seats all the way back, you won't be able to touch the foot wells. The interior is nicely furnished, although more functional than luxurious. Visibility is good, except that it is restricted to the rear when the top is down. The driving position is what you'd expect from a sports car, and I found the seats comfortable.

On back roads, I found the handling

agile and precise. The steering is power assisted, but you'd never know it. Shifting is smooth and easy, with no sloppiness or notchiness. The brakes seem good, and didn't tend to pull or lock up on the car I drove.

For today's world, acceleration is excellent, and there was no trace of throttle steer (direction change on acceleration or deceleration). With its balanced power and handling, the TR8 could put a lot of fun into driving again, if we only had the fuel to enjoy it.—Ed Jacobs



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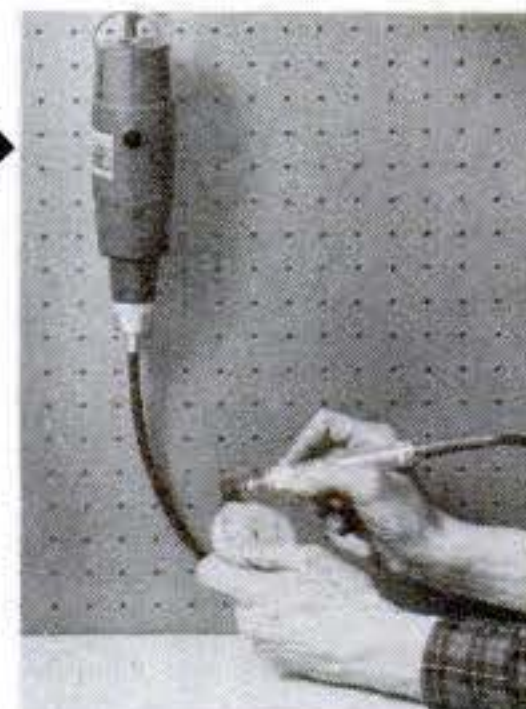


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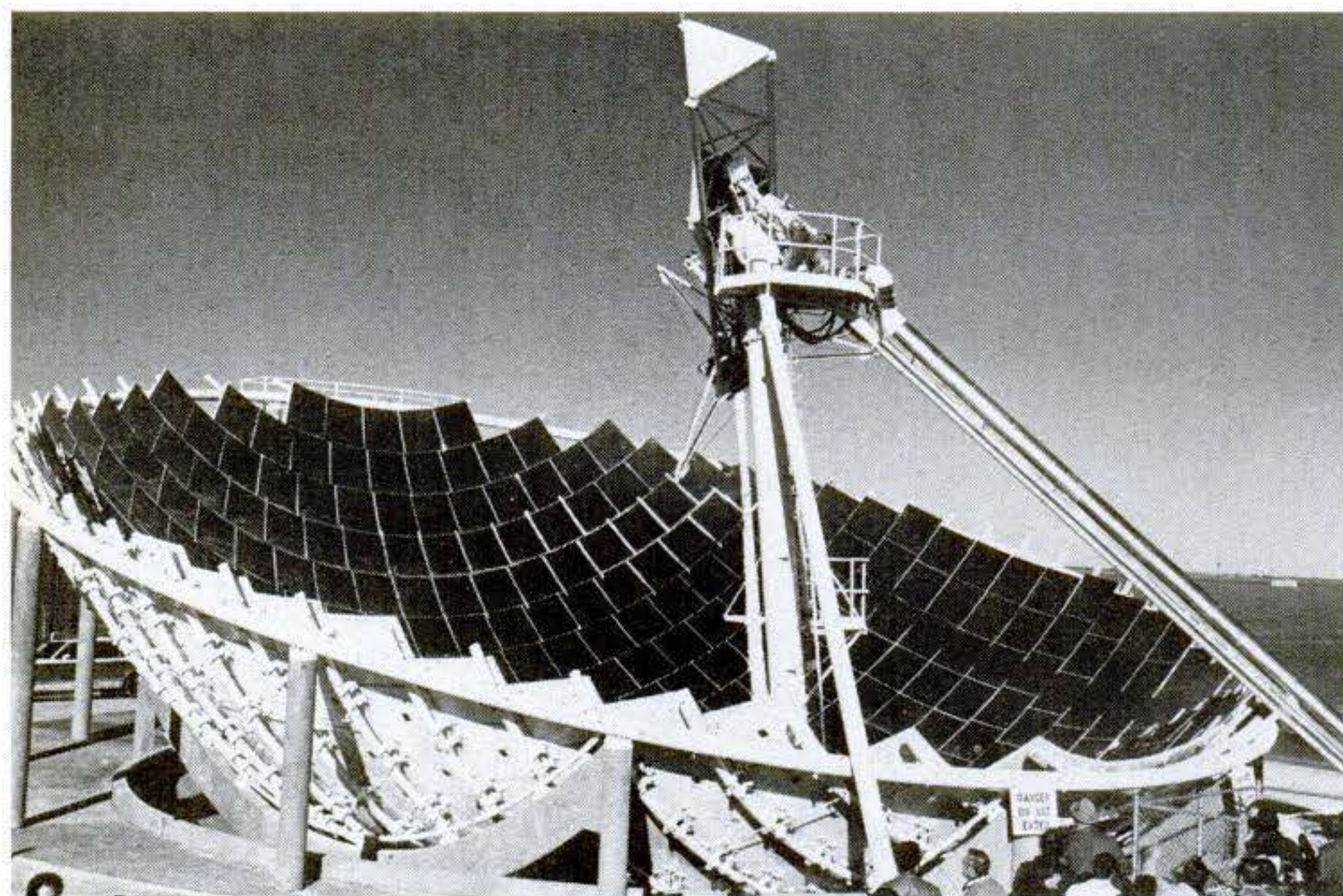
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SCIENCE NEWSFRONT

By ARTHUR FISHER



Biggest solar collector

This 65-foot-diameter solar collector, a prototype for an eventual five-megawatt hybrid power plant to be built by Texas Tech University and the Department of Energy, is the world's largest. The bowl is fixed, and contains 430 mirrors, each a little over a yard square. An 18-foot-long cantilevered receiver moves to track the sun so that it is always at the focus of the bowl.

The hybrid power plant, scheduled to be completed at the end of 1982, will generate about 30 percent of its output from solar, the rest from fossil fuel. The solar portion will consist of 10 200-foot bowls like this one, each with 2000 mirrors.

What about storage? Says Dr. John D. Reichert of Texas Tech: "Storage of solar

power is expensive. Although we do have some storage, we believe that too many mirrors and too much storage right now is not the way to go. During the day when the sun is doing its thing, fine—at night you move the throttle up and burn fossil fuel."

Space telescope mirror

Work on the 2.4-meter primary mirror for NASA's Space Telescope [PS, June '75] is proceeding apace. Here, engineers at Perkin-Elmer check out the big mirror (below, left) before the final grinding and polishing operations begin. You can see the cellular structure of the inside of the mirror through the concave faceplate that forms the front surface. Widely used for large telescope mirrors, this kind of con-

struction saves weight while retaining stability. A thin coating of oil glistens on the faceplate, in a technique that enhances visual inspection of the mirror surfaces and internal structure.

The Space Telescope is scheduled for launch by the Space Shuttle in late 1983.

Earliest life dated

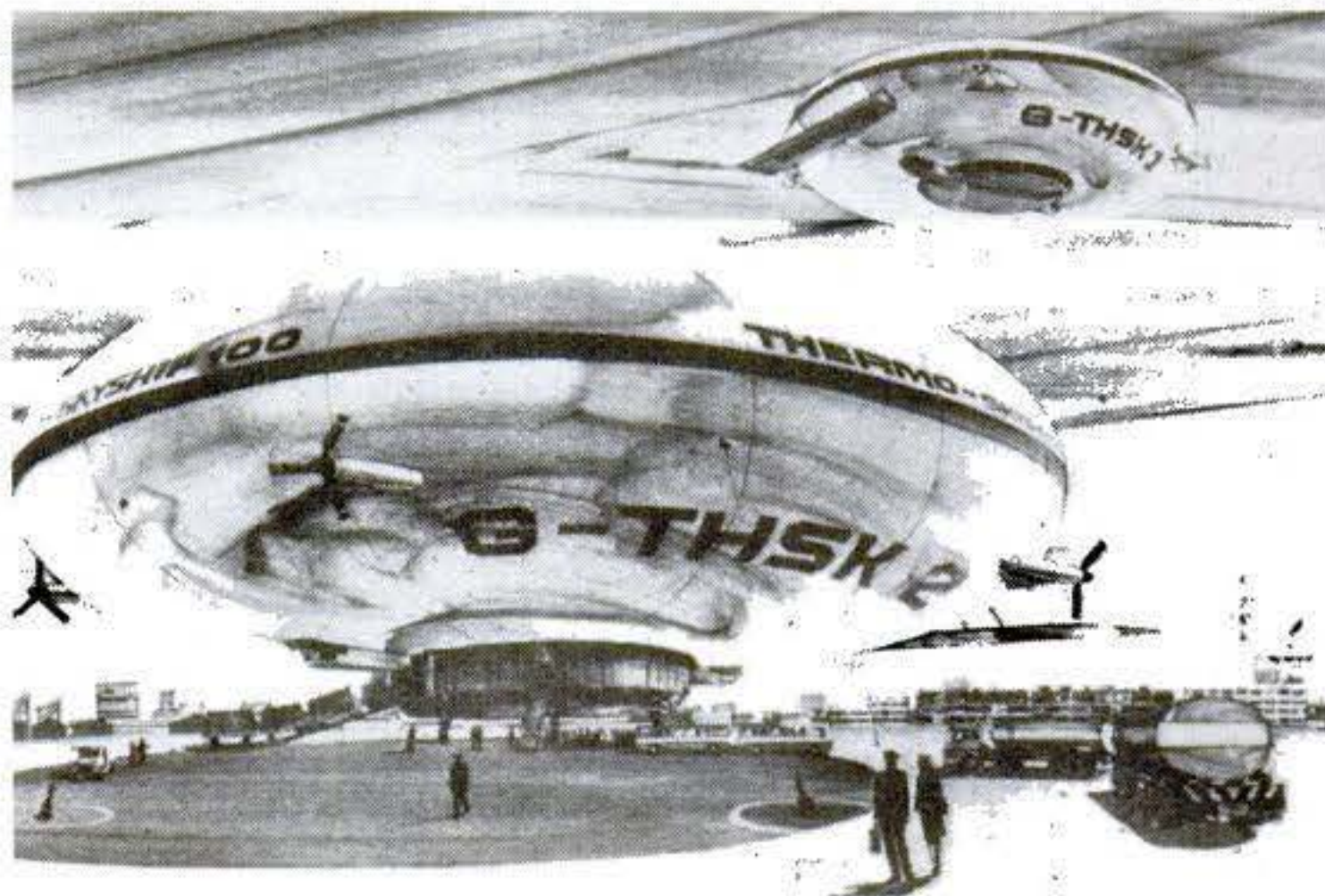
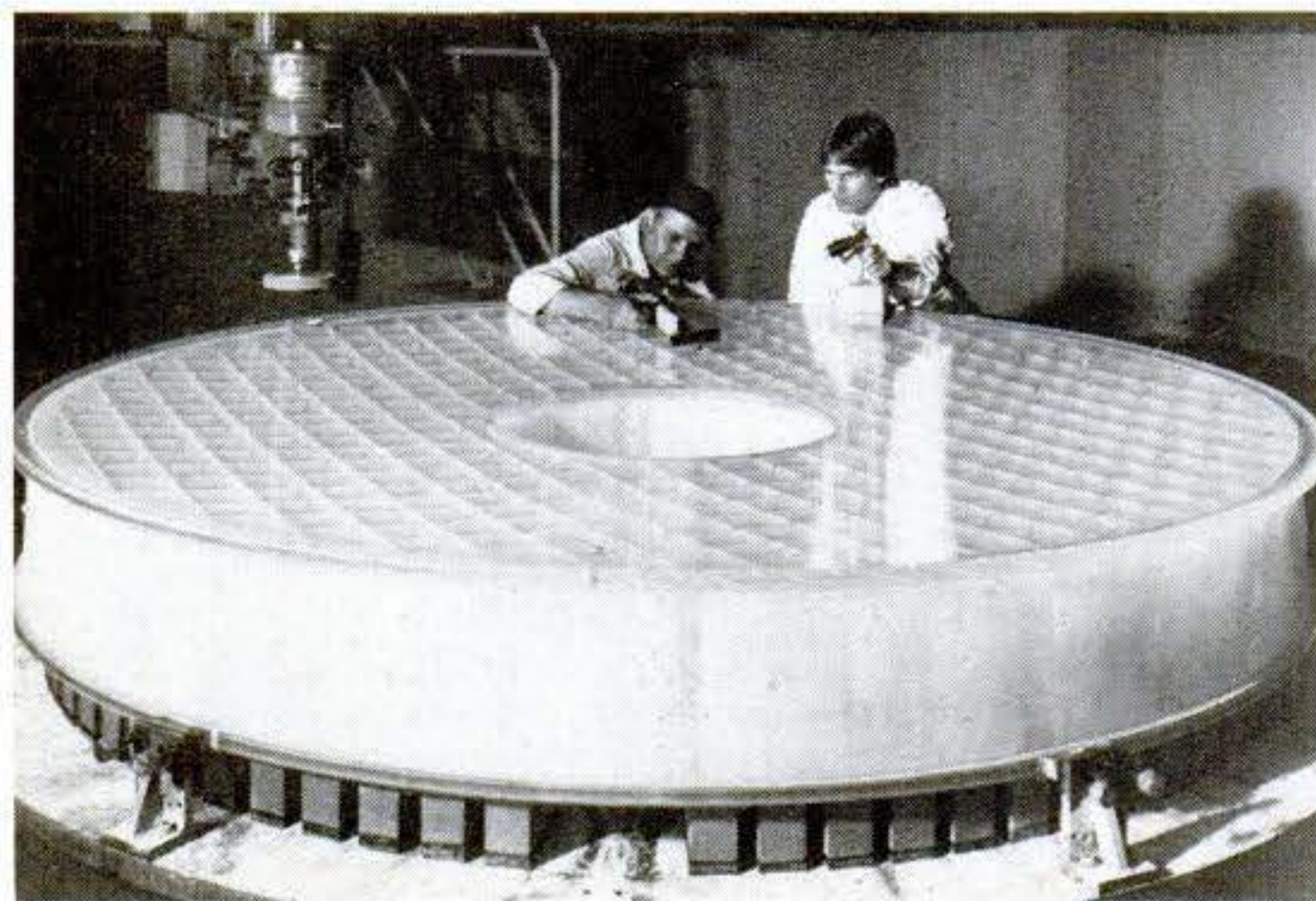
An international team of scientists of various stripes, working together at the University of California, Los Angeles, has announced the first major finding of a 15-month research project into the origins of life: Life existed on Earth 3.5 billion years ago, only a billion years after the formation of our planet. This pushes back the origin of life by some 400 million years over the earliest previous firmly established date.

The evidence came from sedimentary rocks gathered in Western Australia by one member of the 15-man team. Exhaustive analysis revealed the presence of microfossils: layers made up of mats of tiny, bacteria-like cells. Dating methods [PS, Nov. '79] proved the rock to be 3.5 billion years old. A 3.8-billion-year-old rock from Greenland, which had been regarded as a likely candidate for microfossils, proved to be barren. The discoverer of the Australian rock, Dr. Malcom R. Walter of the Australian Bureau of Mineral Resources in Canberra, doubts that any well-preserved sedimentary rocks older than 3.5 billion years can still be found on Earth.

Liftoff for Skyship?

A concept that's been on the drawing boards for some time has apparently received (according to British Information Services) a go-ahead at last. Thermo-Skyships, Ltd., a British firm, will build a 70-meter-diameter preproduction model of its helium-filled craft. It is designed for short-haul operation and will carry about 10 tons in vertical takeoff and landing mode (VTOL) or about 19 tons in short takeoff and landing mode (STOL), with a maximum speed of 90 knots. Its designers claim that the Thermo-Skyship will achieve unparalleled maneuverability and stability because of its disc shape, the station-keeping ability of its four turbo-prop engines, and its exploitation of various schemes for lift and propulsion.

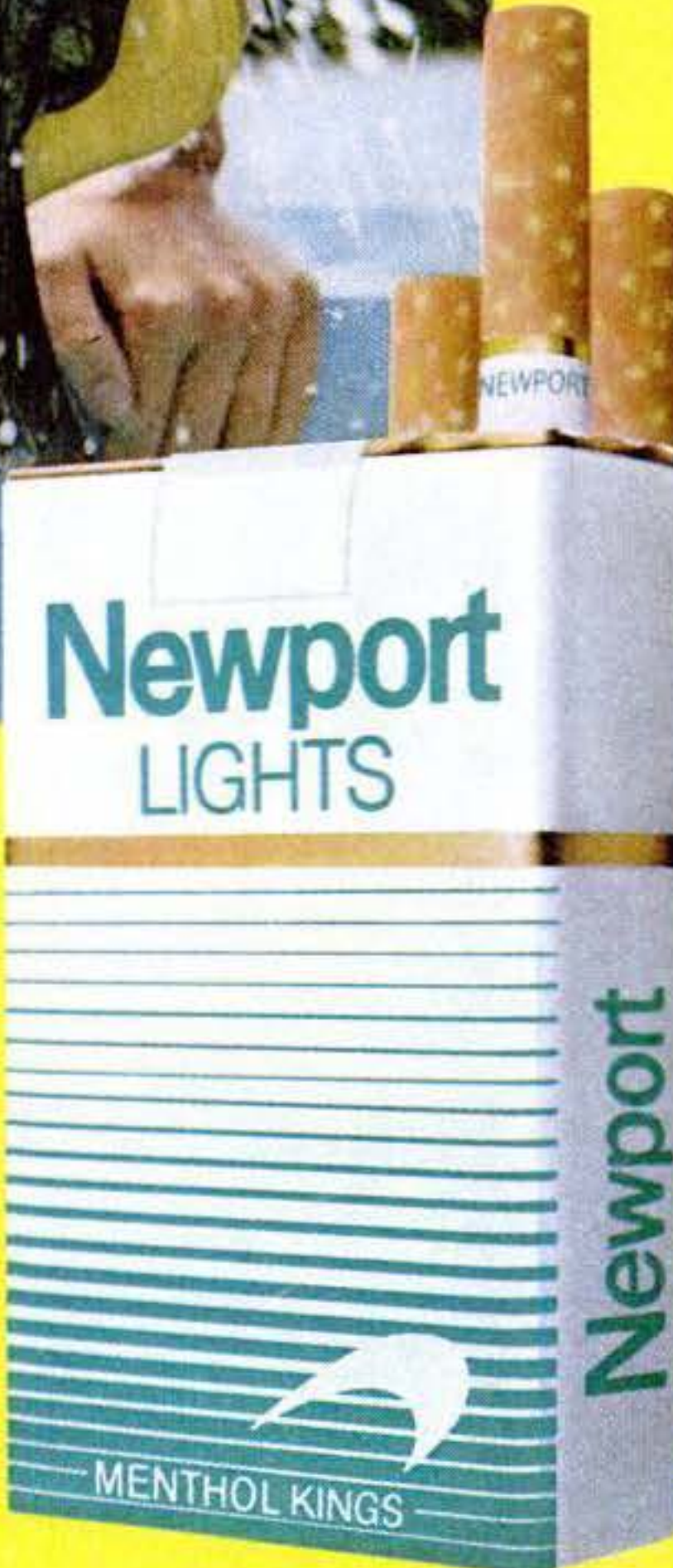
Continued



Revive your taste!

A woman with long dark hair, wearing a yellow tank top, is splashing in water. She has her mouth wide open in a shout or scream, and water is spraying around her face. The background is a bright, sunny outdoor setting with green foliage.

Newport Lights
*Newport pleasure comes
to low-tar menthols*

A pack of Newport Lights cigarettes. The pack is white with blue horizontal stripes. The top of the pack is open, showing several cigarettes. The brand name 'Newport' is written vertically on the side of the pack. The words 'Newport LIGHTS' are printed on the top flap. At the bottom, it says 'MENTHOL KINGS' next to a small logo of a bird in flight.

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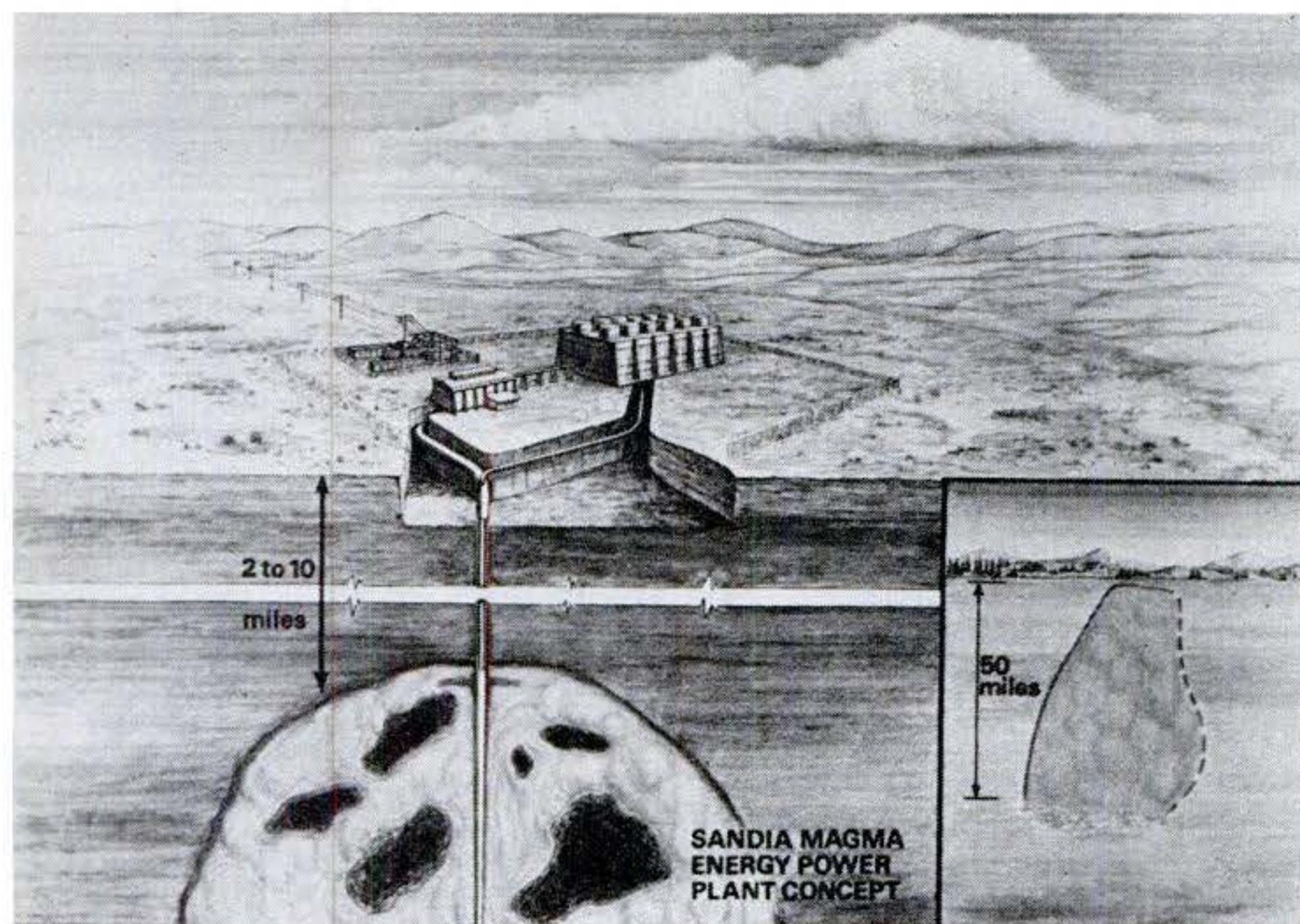
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[Continued]



Energy from molten rock

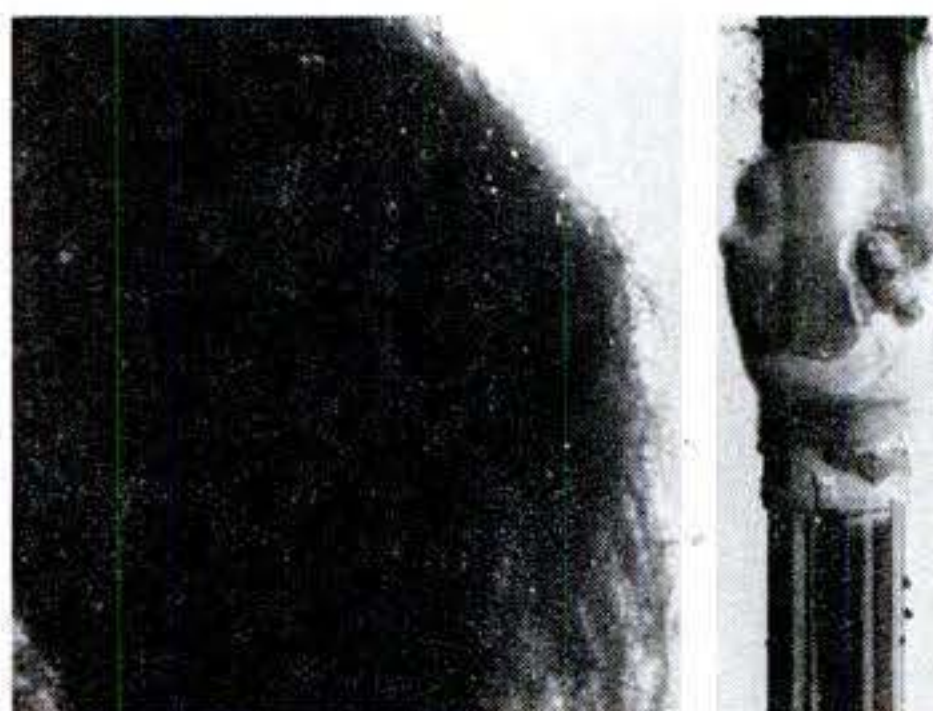
Some years back, on one of my periodic tours of Sandia Laboratories in Albuquerque, N.M., I was introduced to a scientist working on a future energy source that was dubbed "Magma Tap." Its speculative nature could be judged from the closet-size office awarded to its chief researcher. But its prospects were enormous: nothing less than tapping the heat reserve in the vast lakes of magma—molten rock—that underly the Earth at many points, including active and dormant volcanoes.

Now this idea, though still reserved for the future, has achieved respectability as an alternate energy source. The National Magma Energy Advisory Panel—experts in volcanology, geophysics, magma petrology, tectonics, geochemistry, and materials science—has concluded that the extraction of energy from magma appears promising, and that it is worth investing in three to five more years of research to see if the scheme can be practical in the future.

How big a resource are they talking about? The U.S. Geological Survey estimates that the total energy content of magma lying within 10 kilometers (about six miles) under the Earth's surface inside the continental U.S. is 5000 times the total annual energy needs of this country.

The theory of Magma Tap is illustrated in the artist's concept above. A heat-exchange system would be sunk directly into the body of magma lying no more than 10 kilometers beneath the surface, at a temperature of some 1000–1250 degrees C. The extracted heat would generate electricity at the surface in a conventional way—with steam turbines, for example. It is also possible that synthetic natural gas could be produced.

Research over the past few years has concentrated on the known reserve of magma under the Kilauea Iki lava lake on the island of Hawaii. Experimental drilling



has shown that conventional exploratory drilling techniques should be adequate down to the molten-rock margin, where rock is solid even at a temperature of 1000 degrees C, but novel methods will be needed to advance through the molten rock. Tests have already been successfully carried out on a prototype jet-augmented drill that cools the magma ahead of the bit. Much of the research is being conducted at Sandia's Magma Simulation Facility. Here, experiments can be conducted in molten rock at pressures up to 60,000 psi and temperatures up to 1600 degrees C.

New ocean-current sensor

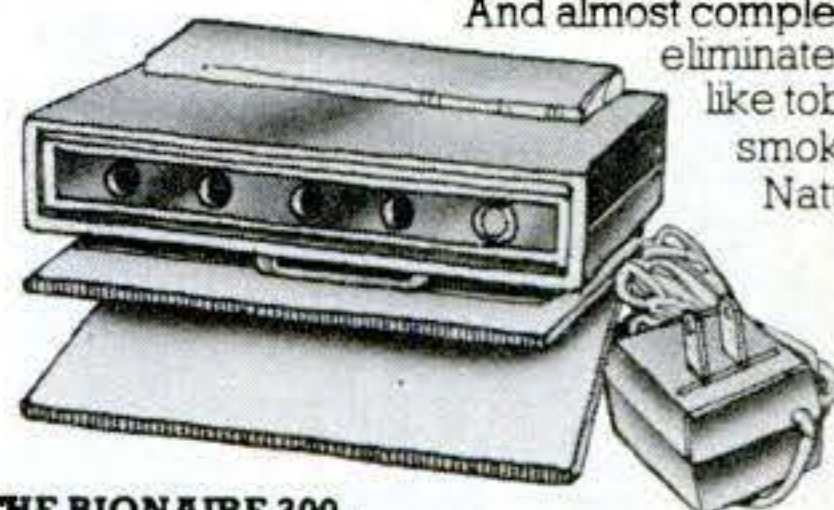
The photo above shows the dramatic difference gained by a new antifouling technique developed by the Navy's Civil Engineering Laboratory for its solid-state thermal ocean-current sensor. The sensor was developed to provide a small, accurate instrument that could measure slow-moving currents inches above the ocean floor. It is only one inch long. The sensor at right has a protective layer of platinum, which induces the formation of a layer of chlorine, a potent inhibitor of fouling from marine organisms. The identical sensor on the left is bearded by a mass of biofouling, including algae, because it did not receive the platinum treatment. Both were under sea water for nine weeks.

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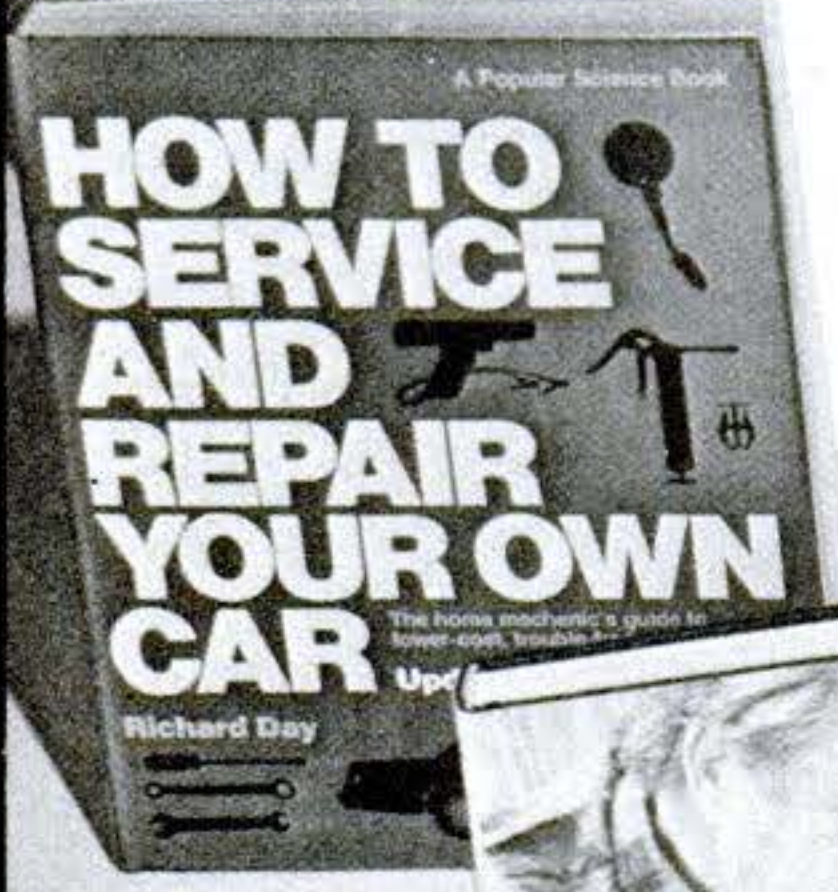
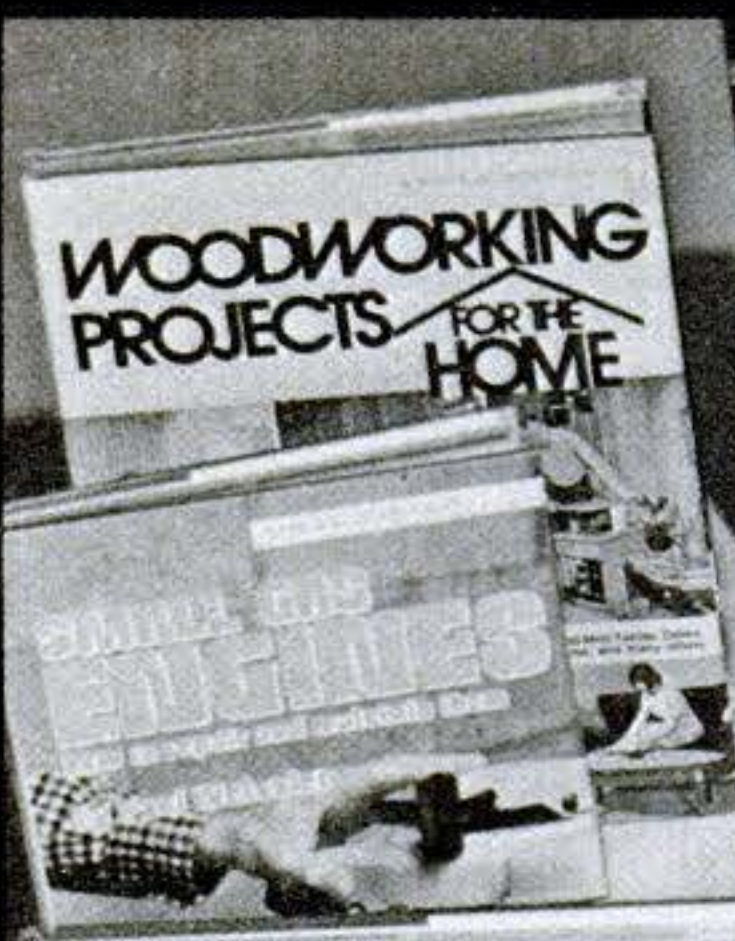
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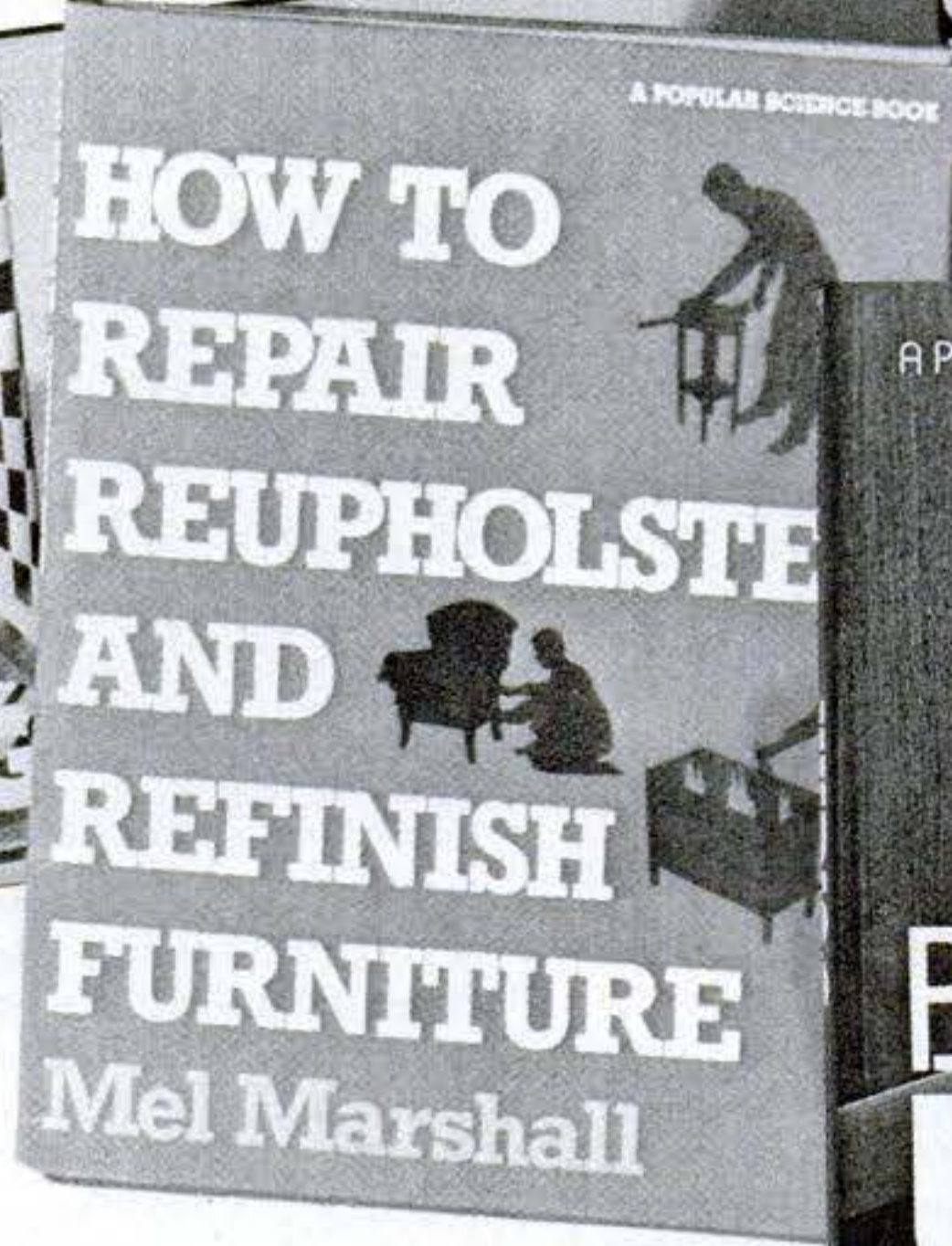
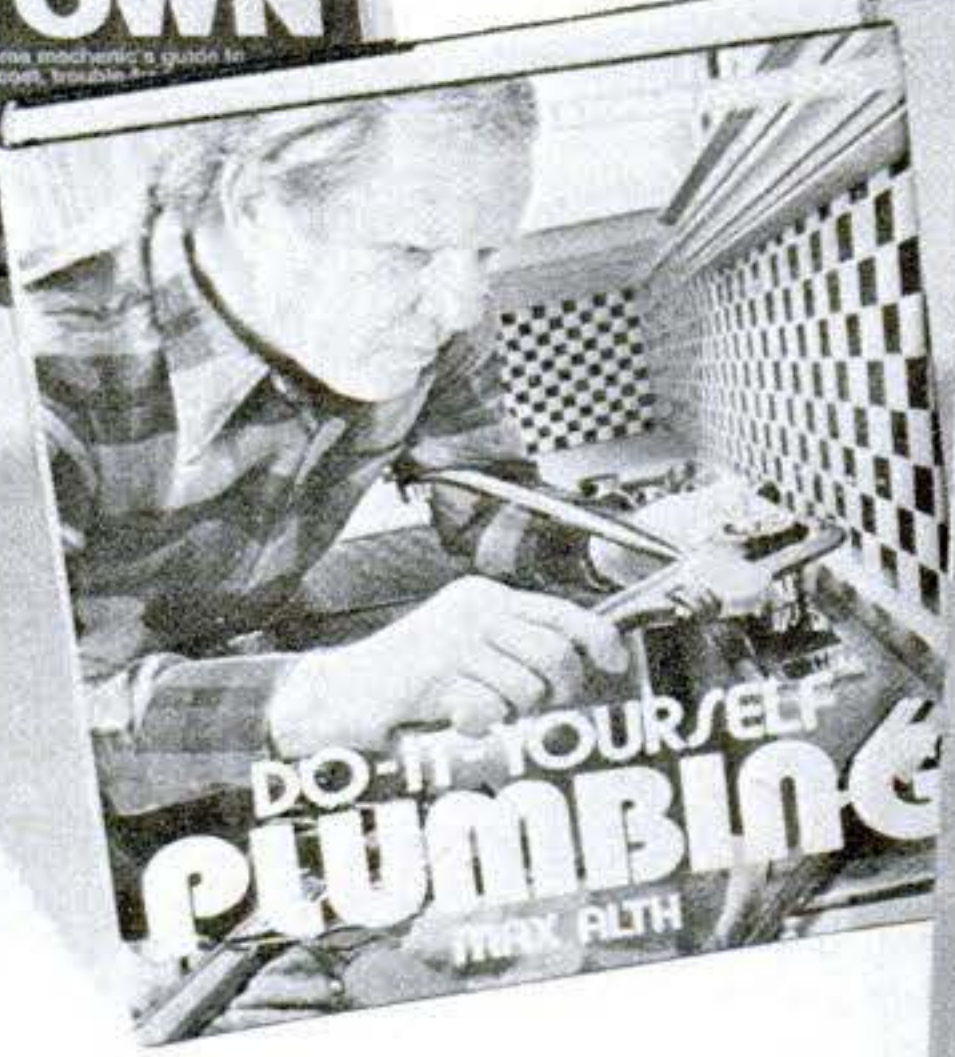
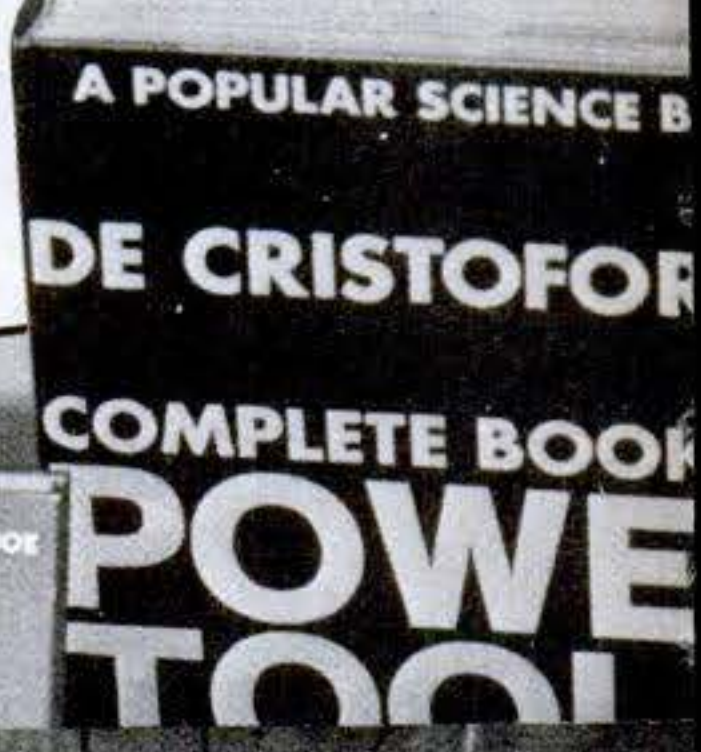
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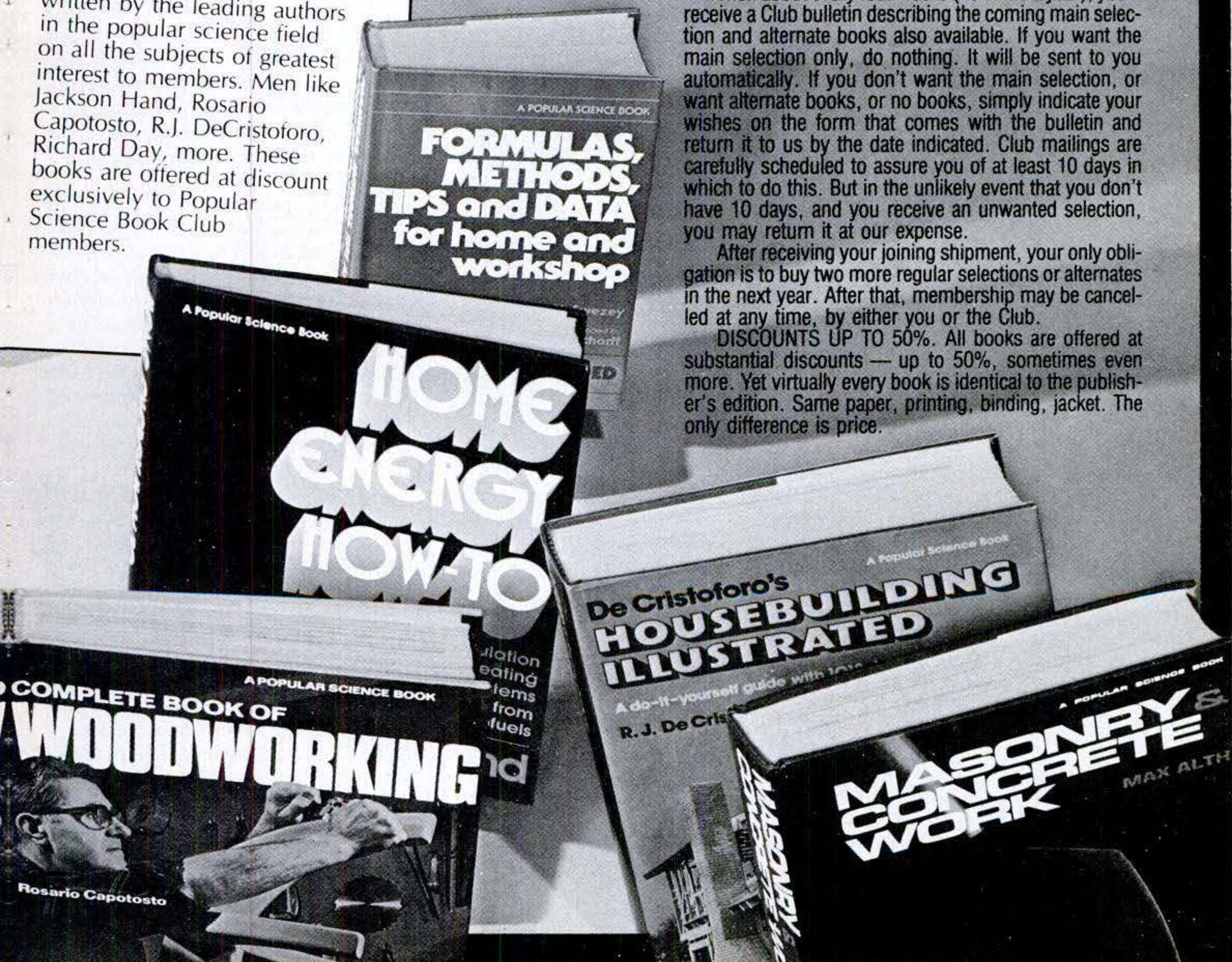
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10-pound gas-powered hedge trimmer



My experience with commercial hedge trimmers is that electric ones are bothersome because of their long cords, and gas-powered ones are so heavy that they tire my arms quickly. Not so with Echo's new HC-140 gas trimmer: Its 10 pounds are comfortable, cushioned, well-balanced, and easy to handle.

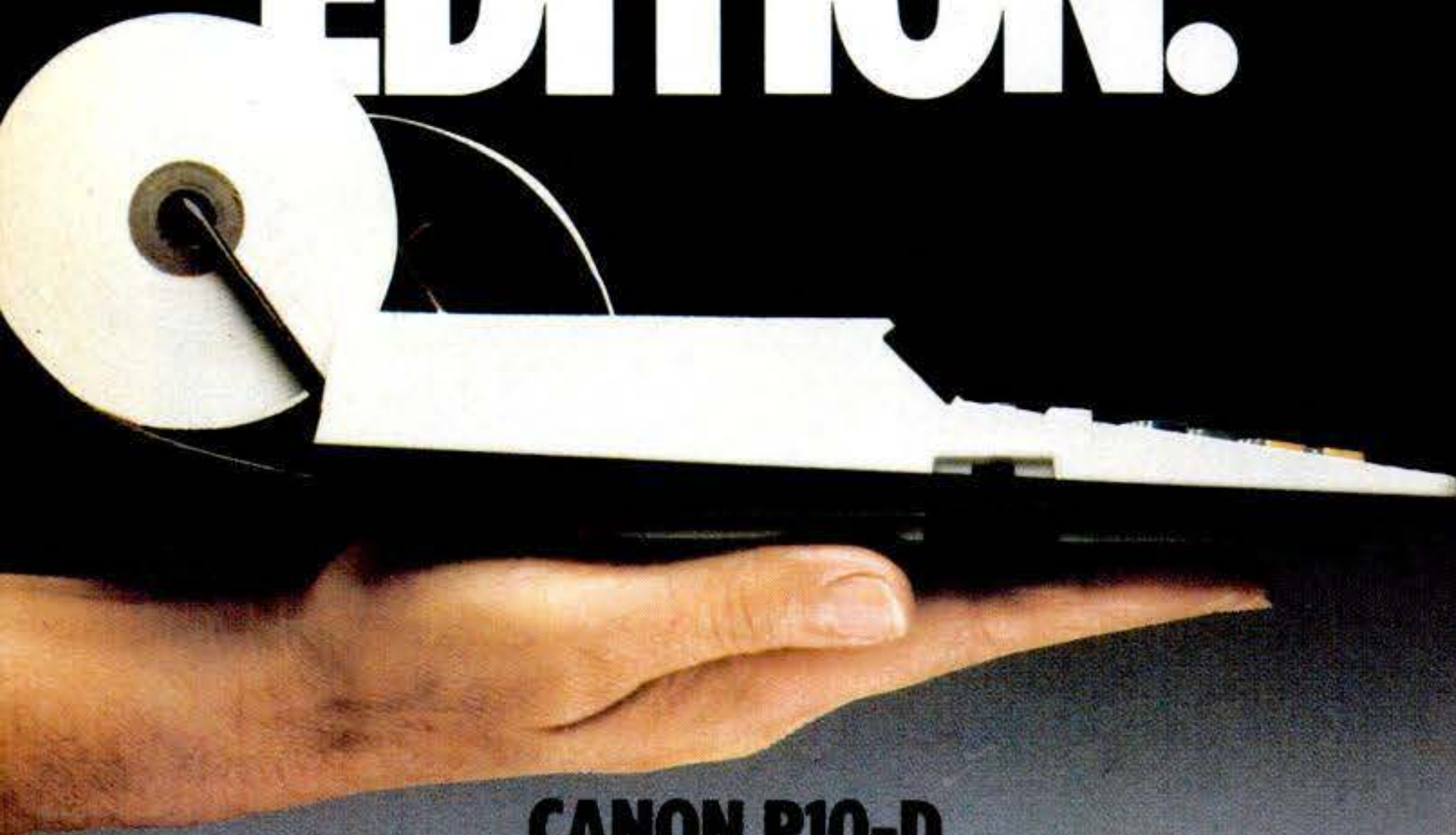
As is typical of Echo engines, this little 13.8-cc (0.84 c.i.d.) power plant didn't kick and squirm when I pulled the starter cord. Nevertheless, I appreciated the stirrup-type handle that allowed me to toe-hold the trimmer firmly on the ground for safer starting.

A centrifugal clutch that cuts in at about 3000 rpm prevents the reciprocating, double-edged blade from moving until you squeeze the trigger. And the trigger is blocked from accidental tugs while you're moving about by a safety-grip throttle lock that requires a firm grip on the handle to start the trimmer. I also liked the wraparound front handle that allows you to cut in any position without contorting your wrist.

Opening the throttle for the first time was a little surprising. The engine and blade shuddered a bit, then smoothed out as the engine came up to speed. The rather flexible mounts on both handgrips tend to emphasize this, but I found they did a fine job of isolating vibration from your hands during actual cutting. Although the instruction book advises against cutting branches over 1/4-in. thick, I plowed through some heavier stuff—some of which was old, hard growth—without problems.

Echo also makes a heavy-duty Model HC-200 for the pro market, but at \$129.95 the HC-140 should be a hit for home hedge trimmers. Echo, Inc., 3510 MacArthur Blvd., Northbrook, Ill. 60062.—E. F. Lindsley

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Rover 3500 sporty new sedan



SAN DIEGO, CALIF.

The twisting roads through the rugged mountains east of here proved to be a fine testing ground for the sleek new Rover 3500, a luxurious, five-passenger hatchback sedan that marks Rover's return to America after a nine-year absence.

Sophisticated U.S. computer technology helped develop new aerodynamic, safety, and structural elements for the Rover. That's only fitting, since the car was designed with American standards in mind.

The engine is a responsive 3.5-liter (215-cu.-in.) aluminum V8 with fuel injection. A five-speed manual transmission is standard; a three-speed automatic is optional. Air conditioning, cruise control, power windows, power door and trunk locks, load-leveling shock absorbers, and an adjustable steering column are also standard equipment.

Inside, you'll find a spacious and airy cockpit, with excellent driving position and all-around visibility. The velour-covered, fully reclining seats are well-designed and comfortable. With the rear seat folded, cargo volume is generous, and almost reaches EPA's station-wagon classification.

Since engine, transmissions, and final-drive assemblies are shared with the also-new Triumph TR8 [see page 28], this is one family sedan definitely intended for sporty driving. It rides solidly on the open road, and feels firm and well controlled. Handling is nice, with no undesirable characteristics. Response to steering movements is quick and accurate, although the steering itself seems to have some induced heaviness and feels rather dead when on center. With any movement away from center, however, it comes alive.

Power is more than adequate with the automatic, but is better with the five-speed. My only substantial complaint about the car is its unusually high fan noise at cruise, which is out of place in a \$16,000 car that is otherwise agreeable.—*Ed Jacobs*



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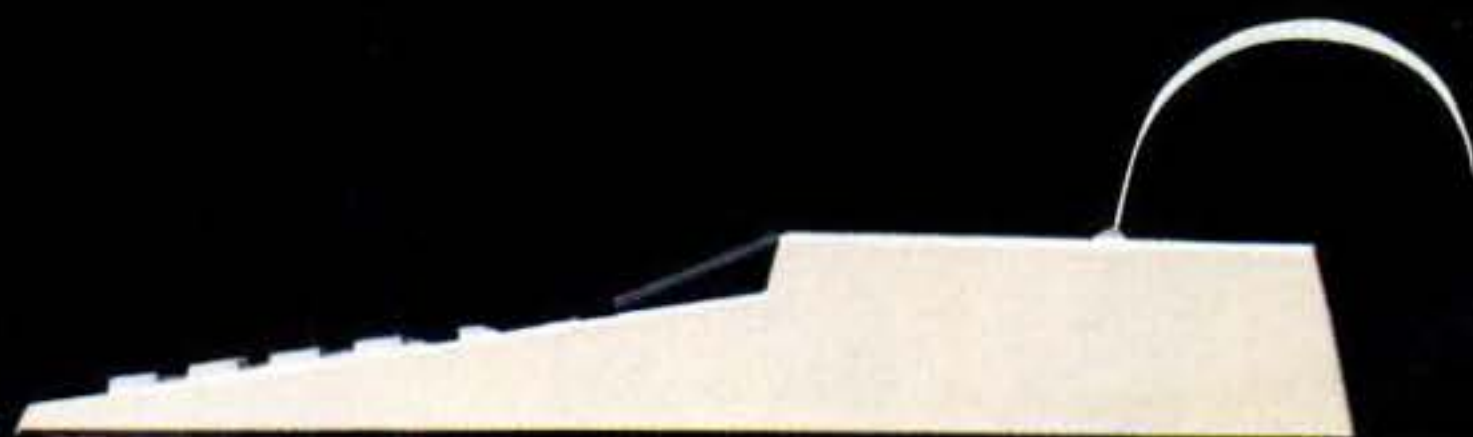
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High-performance sporty cars

—fading but not disappearing

By **JIM DUNNE** and **ED JACOBS**
PHOTOGRAPHS BY JOHN KEATING

Sporty cars have special appeal. As long as active drivers want powerful, responsive cars, they will remain an irresistible attraction. But the cars will change. That is clear from an examination of three of today's best: Chevrolet Z28 Camaro, Ford Mustang

Cobra Turbo, and Pontiac Firebird TransAm Turbo.

Mustang leads the trend toward leaner design and more efficiency. TransAm and Z28 are in the classic mold, where performance holds first priority. We found marked contrasts between the two types, though each offers the one indispensable ingredient: driving excitement.

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Camaro Z28	Mustang Turbo	Firebird Turbo
Acceleration	5	5	5
Braking	2	3	3
Handling	3	4	3
Maneuverability	5	5	5
Quietness	0	0	0
Roominess	3	3	3
Visibility	2	5	2
Entry/exit ease	3	3	3
Ride comfort*	2	2	2
EPA economy	1	3	1

*authors' opinion

In acceleration, the Camaro was the fastest, with an average zero-60-mph time of 9.9 seconds. The TransAm, even with a turbo, could do only 11.3 seconds. The Mustang had too few cubic inches to really compete; it was outclassed at 13.3 seconds. Its 800-lb. weight advantage goes a long way, but can't work miracles.

Continued



Reminiscent of their racing heydays, a Chevrolet Z28 Camaro, Pontiac Firebird TransAm Turbo, and Ford Mustang Cobra Turbo (l. to r.) sweep into a right-hander.

Mustang's wide, sticky tires made it feel the most sure-footed in both the slalom (shown) and high-speed lane-change tests. The car also turned in the fastest speed in lane-change.

Ford, however, is no longer catering to the performance-car buyer in the old way. Performance is still important, but the primary need now, Ford believes, is fuel economy. So you shouldn't be surprised to learn that the Mustang is the most fuel-efficient, while the most powerful car, Firebird, delivered the poorest economy.

When they abandoned brute power, Ford's engineers gave handling top priority. So they developed the optional TRX handling package, which includes special springs, shocks, sway bars, wheels, and Michelin TRX tires. Ford is justifiably proud of this setup, which is crisp, predictable, and hangs on to the road with uncommon persistence, with only some easy-to-control tail-end skittering on rough pavement.

TransAm and Camaro are more power-oriented, but do have good handling characteristics for American cars, although not at the same levels we've seen on them in the past.

Part of the accepted sporty-car ambience seems to be confined front seating and even tighter accommodations for rear-seat passengers. In Mustang, though, we found more *usable* room for passengers. Combined front leg room and foot room are excellent compared to the others. That's surprising, because Mustang is nearly 20 inches shorter than Camaro or Firebird.

The low seating position in the front of the GM cars contributes to a poor field of vision for the driver, especially to the front, which is further aggravated by a high cowl and long hood-line. You just can't see the road near the front of the cars. Rear-seat room in Camaro and Firebird is too tight for the average-size adult, even on short trips. Mustang, though the specifications don't really show it, feels more spacious.

How well do the turbos do their job? Well, Mustang needs the turbo just to qualify as a sporty-class performer. Boost comes on mildly and gradually; you'll miss the old jolt off the line. Over 30 mph, though, acceleration is more than satisfactory. TransAm's

Continued

Firebird Turbo's four-wheel disc brakes were best in hot-brake panic stop (above left), but tied Mustang for longest stop when cold. Z28 Camaro (left) easily got a top rating in low-speed slalom, as did Firebird and Mustang.



The U.S. was founded by a group of individuals who rebelled against the oppressive policies of King George in England. Today, this same spirit of independence, a uniquely American phenomenon, underlies a growing displeasure with government tax and spending policies. This viewpoint is a healthy sign. Our society can remain the freest and most prosperous in the world if government power is held in check by us, the citizens who make up the country. Recent passage of laws (such as Proposition 13) are an indication of a growing wave of protest against wasted tax dollars. The effort is getting stronger and more vehement every day.

The largest tax each one of us pays is Federal Income Tax. Yet, the largest corporations and the wealthiest individuals often pay the least amount of tax. According to an article in a leading newsletter, 17 huge corporations paid no federal income tax in a recent year, although they had a world-wide income of \$2.5 billion. Numerous tax loopholes were used. The list includes United States Steel, Bethlehem Steel, Armco Steel, General Dynamics, Singer, Phelps Dodge, American Airlines, Philadelphia Electric and The Chase Manhattan Corporation. The burden caused by these non-taxpayers must be assumed by "somebody." "Somebody" is always the wage earner. There is, therefore, a major inequity under the law which favors the wealthy and, most especially, corporations. In America today we have what could be called a "Corporate Society."

Some individuals have become so upset with these startling inequities, they have stopped paying taxes and have in many cases even ceased to file tax returns. This approach, however, is fraught with danger and has resulted in stiff fines or prison sentences when the government locates and prosecutes the courageous individuals.

You Can Become Part of "The Corporate Society"

Rather than break the law and suffer serious consequences, there is a safer and more viable alternative. You can use the same type of smart thinking as those who own and control great wealth. The big corporations are not necessarily immoral. However, they do get the best advice available on tax matters.

You, as an individual, can now use all the tax loopholes for your own self interest. Thus, you legally gain the advantages yourself as do the huge corporations. Rather than break the law, you can use it to your advantage. Perhaps the best way to accomplish this, as well as reduce your tax burden is through incorporation, the legal form of tax rebellion.

Surprisingly enough, the government encourages incorporation with a number

Wage Your Own Personal Tax Revolt

Like the early pioneers who started this country, many people are rebelling against the near confiscatory taxation at all levels of government. The federal government consumes the taxpayer's cash at the rate of over \$800,000 per minute, and the amount that is wasted is scandalous. The citizens are mad as hell and they're not going to take it any more.

There is but one answer left!

of favorable laws, especially in the area of taxation. In fact, it is rare to find a successful individual who is not incorporated. Incorporation is favored by nearly all millionaires. It is one of the causes of wealth, not its effect. Think about it. Can you think of a single wealthy individual who doesn't own and control his own corporation? It is rare indeed. Let's face it, the first step toward achieving the American Dream in our corporate society is probably incorporation.

To add even more impetus to the idea of starting your own corporation, passage of the recent Revenue Act makes incorporation the ultimate tax shelter. This act and the earlier ones close the door to practically all other tax shelters and loopholes. The tax rate on corporations (especially smaller ones) has been substantially reduced, to as low as 17%.

Favorable laws such as the investment tax credit are most helpful when buying equipment. Even if you incur losses in one year you can deduct those losses over several profitable years.

More Advantages...

You can set up a corporate medical plan wherein you deduct from your taxes every dollar spent on medical and dental care, drugs, and health insurance for yourself and your family. You can also get tax deductible group life insurance even if the "group" consists of only one person.

It is important to note that potential tax savings are not the only reason to incorporate. Another chief value is that it limits your liability to the assets of the corporation in the event of a lawsuit. If you do business as an individual or partnership, you can be sued personally,

"Over and over again courts have said that there is nothing sinister in so arranging one's affairs as to keep taxes as low as possible. Everybody does so, rich or poor; and all do right, for nobody owes any public duty to pay more than the law demands; taxes are enforced exactions, not voluntary contributions. To demand more in the name of morals is mere cant."

Judge Learned Hand

which could put your house and other assets in jeopardy

You can put more money (25% and more of income) into your corporation pension plan. This is more than a traditional "Keogh" plan which has a maximum contribution of \$7,500 a year, or even an I.R.A., where the maximum that can be sheltered under special circumstances is only \$1,750.

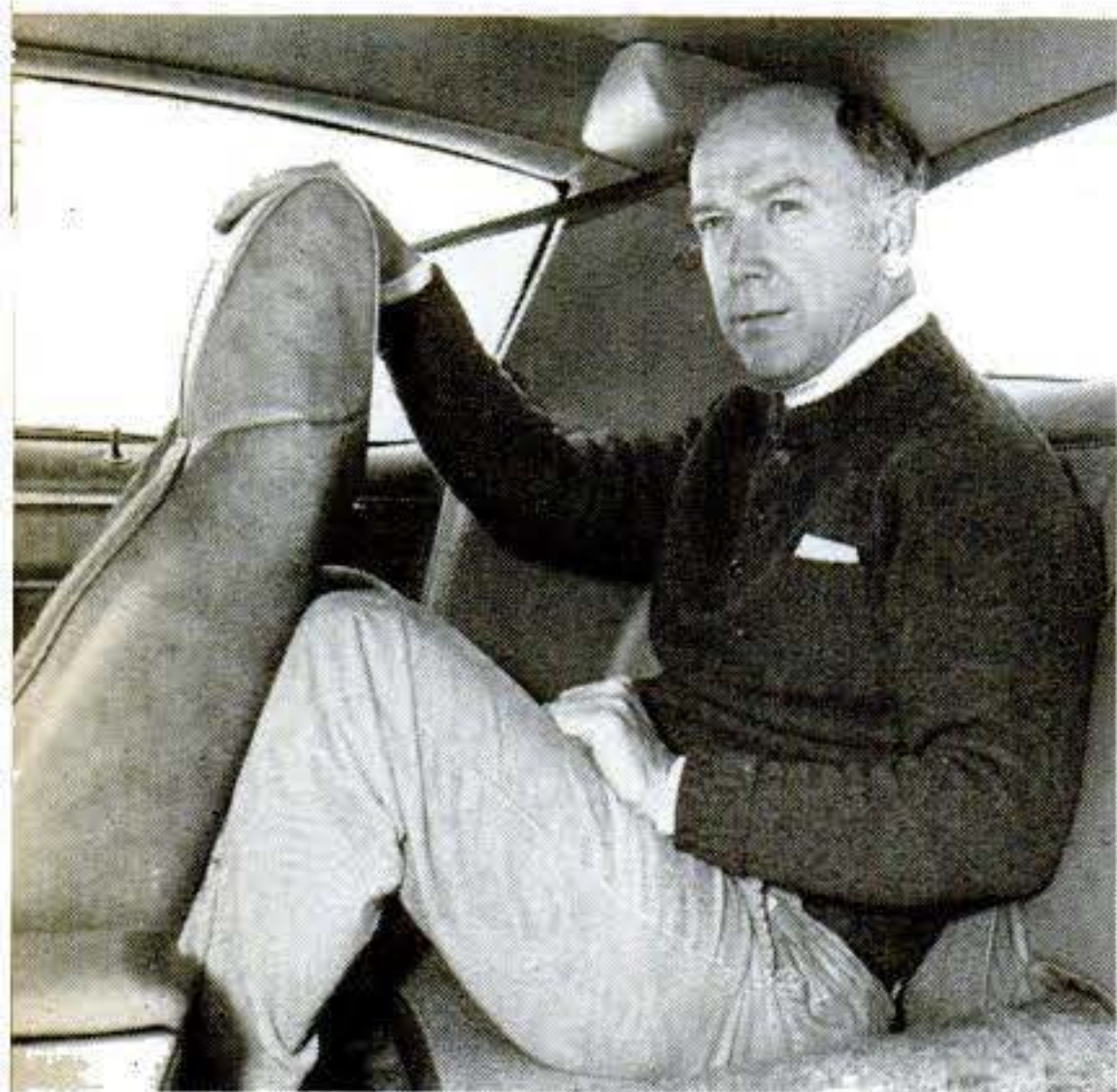
In these times of growing inflation and periodic ups and downs of the economy, your own corporation is probably the only way that you may maintain control over your economic destiny. And you can often benefit from incorporation without leaving your present job. More about that in a moment.

You Can Incorporate Simply, Easily and Inexpensively.

Up until now, throughout the majority of history, incorporation had one major drawback: high legal fees. Lawyers today charge stiff fees, up to \$2,500 for incorporation. The truth is that you can easily incorporate yourself for under \$50. A remarkably easy and inexpensive method of incorporating is contained in a book called *How To Form Your Own Corporation Without A Lawyer For Under \$50*. It comes complete with all the tear-out forms required to start your own corporation... minutes... bylaws... everything you will ever need. The author, Ted Nicholas, has helped thousands of people start their own corporations and has saved them millions of dollars in the process — and many millions more in taxes.

It is very easy, and we will show you how. We'd like to send you a copy of *How To Form Your Own Corporation Without A Lawyer For Under \$50* for a free thirty-day trial — without risk or obligation on your part. If, for any reason, you're dissatisfied, simply return it for a full refund of your purchase price. We'll also send you a free bonus: The Income Plan — an astounding report that tells you exactly how to turn your present career into a tax-sheltered corporation. The Income Plan — a \$9.95 value — is yours to keep *absolutely free*, even if you decide to return the incorporating system.

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Rear seating is cramped in both Camaro and Firebird, with little knee room when the front seat is in typical position.

turbo response is similar, though more plentiful. The V8's power can be felt at all speeds, but there still is no sudden kick as the turbo comes in.

Chevrolet Z28 Camaro

The Z28 is Chevrolet's top performance model after the Corvette, sharing GM's F-body with Firebird. Though the similarities with Trans-Am are many, each car is developed separately and offers different approaches to handling.

Camaro is perhaps the all-around most responsive car in the group, but did display the unhappy combination of quickest acceleration and weakest hot brakes. When its brakes were cold, however, they were the best—although none of the group produced good stopping distances.

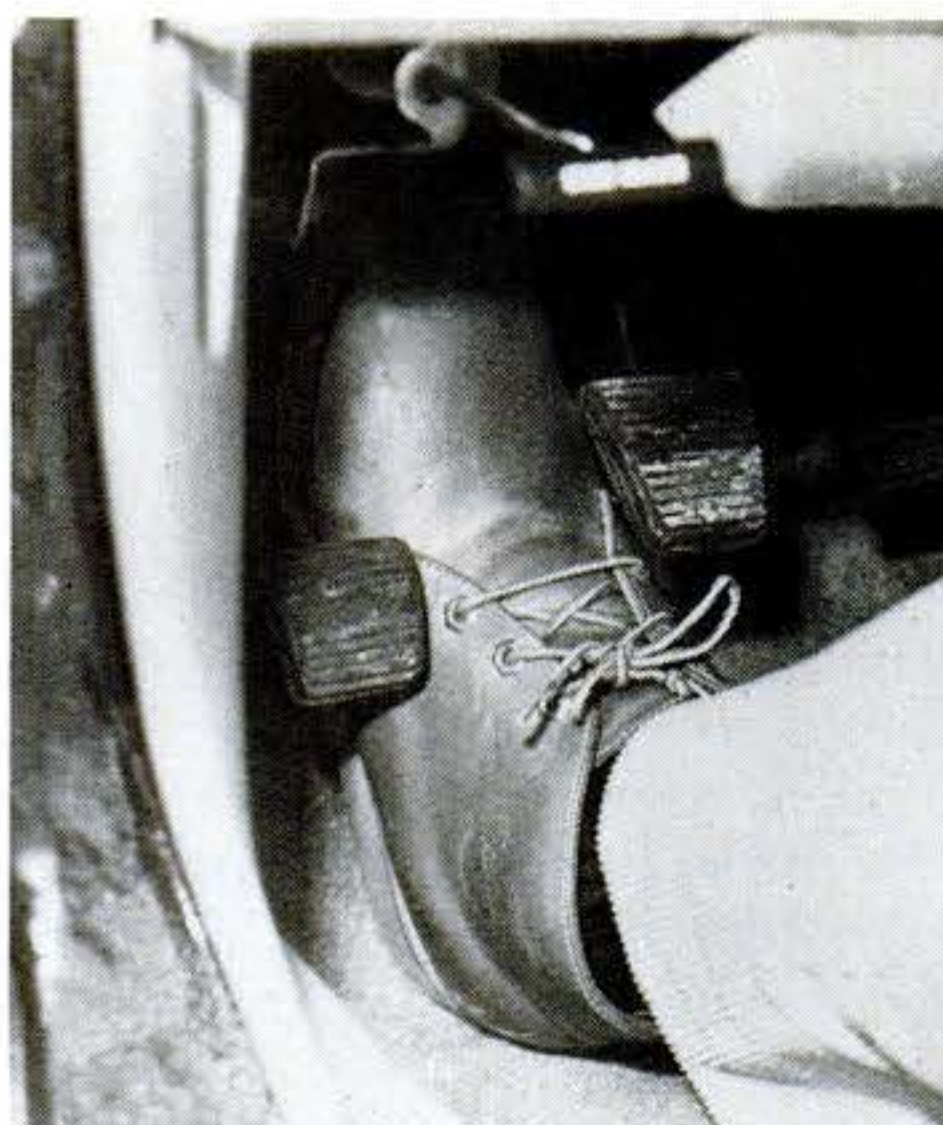
Like Firebird, there are four inches more front legroom than in the Mustang. The driving position is good, but forward visibility is poor. A slight difference in instrument-panel layout from Firebird favors the Pontiac. The Camaro's heater/air-conditioner controls are difficult to see and awkward to operate.

The Z28's four-speed manual transmission has close-ratio gears that seem appropriate for 55-mph highways, since you'll shift to third before reaching the national speed limit. If power-shifting is a driving pleasure, then Chevy has provided an extra measure for you—within the limit.

As in the TransAm, the engine compartment is full of equipment, and is a repairman's nightmare. The 30,000-mile recommended spark plug change interval could be a big cost-saver.

Ford Mustang Turbo

You can call it a sporty car, but the leather upholstery, full instrumenta-



Low dash and tightly grouped pedals of Camaro make it easy to snag foot on parking brake and/or clutch pedal.

tion, and air conditioning lean more toward luxury. A big bonus for Mustang buyers is the choice between hatchback and notchback bodies. The hatchback changes the character of the car immensely, making it possible to carry weekend luggage and sports equipment easily. The rear seat folds forward with the release of a central lever to form a relatively flat floor. Unfortunately, our car's hatchback leaked badly in the rain, and nothing could be carried or stored there.

Driving position is good and all-around visibility is excellent. Front-seat comfort is a little above average. Rear seating is not too comfortable, but is clearly the best in the group.

Although its acceleration is lackluster, the Mustang is still just as much fun to drive in "sports car" country as either of the others. And its superior fuel economy may just make it more satisfying.

Although the car is refined for its second year, the Mustang does have some faults. The instrument panel has all the necessary gauges, but they aren't very well grouped. Then there's the small, toylike steering wheel from the Mark VI and LTD, which seemed to us completely out of place. A larger, huskier, padded-leather type would be more appropriate.

Engine noise is considerably higher in Mustang than in the GM cars, and it can be obtrusive. Maybe the next big project for smaller cars should be to make them all quieter.

Pontiac Firebird Turbo

TransAms are the most highly visible muscle cars on the market today, and many of the old-time reasons for wanting one are still there. The low roofline, long hood, and short rear deck are classic American sporty-car

EPA fuel mileage (mpg)

	Camaro Z28	Mustang Turbo	Firebird Turbo
Highway	17	30	20
City	14	18	14
Calif. city	*	*	*

*not available for California

Observed fuel mileage

(steady-state mpg)

	Camaro Z28	Mustang Turbo	Firebird Turbo
35 mph	22.7	29.7	20.3
55 mph	17.6	22.5	15.5

features. The fact that they cut down on interior room and comfort is accepted. Unfortunately, the Turbo's big hood blister is offset in front of the driver, further restricting the poor forward visibility.

The front seating position is akin to that of a race car, with the seat cushions close to the floor, and your legs stretched out just above floor level. The overall cockpit arrangement—low roof, high console, close-fitting doors—limits space to move around in. Despite this, the driving position is good.

Front-seat passenger comfort is further diminished by the floor bulges that cover the catalytic converters. On the plus side, steering-wheel position and the location of instruments are excellent, and add to the feeling of driving a no-nonsense machine.

Brisk over-the-road driving is pleasant, and the car feels secure and predictable. But in our high-speed lane-change test, it displayed an undesirable tendency to be "darty" when responding to large, quick steering inputs.

Trunk room is tiny—just over seven cubic feet, barely big enough to stash away a set of golf clubs. An inflatable spare helps the situation, but who wants to trade a standard tire for a few more inches of added trunk space? And what do you with the full-size tire when you get a flat? Toss it in the back seat?

Our picks

Mustang is my choice, but not the turbo. I like simplicity. For performance, give me the 255-cu.-in. V8; for economy, the non-turbo four.—J. D.

If you're looking for a classic sporty car, there's only one choice: The four-speed Z28 is long, low, slinky, noisy, powerful, responsive, and good-handling. If the Firebird and Mustang had four-speeds available with their V8's, it'd be a tossup. My selection, though, would be a four-speed Mustang TRX Turbo hatchback.—E. J.

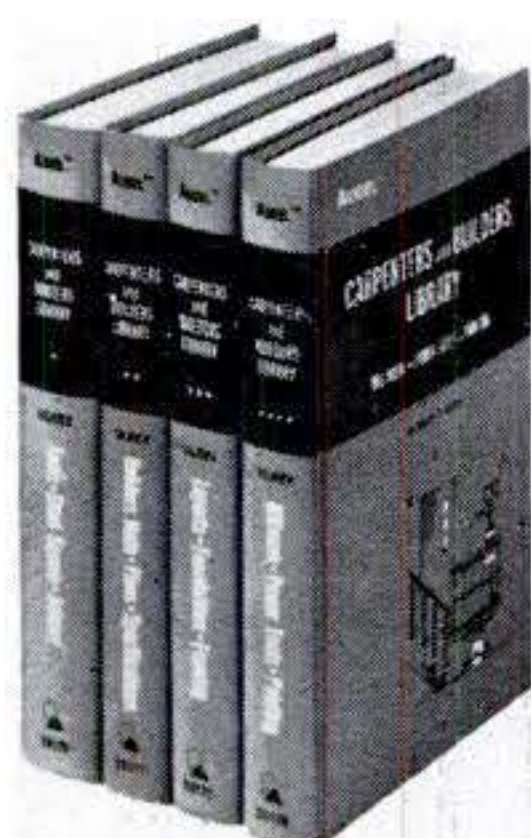
For specs and test results, turn page



**"For an amateur,
he's a whiz.
How'd he get
so good?"**

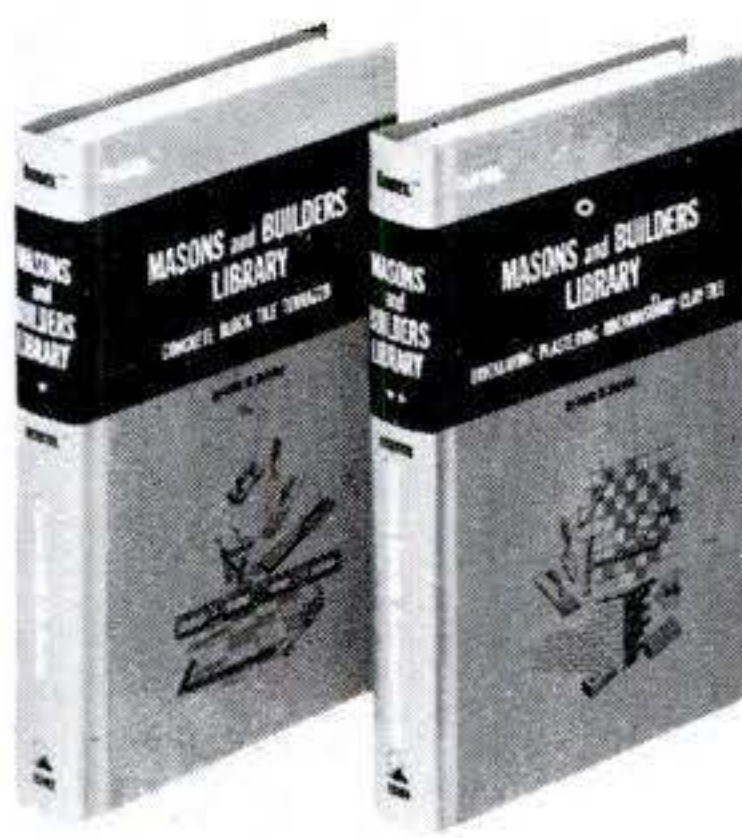
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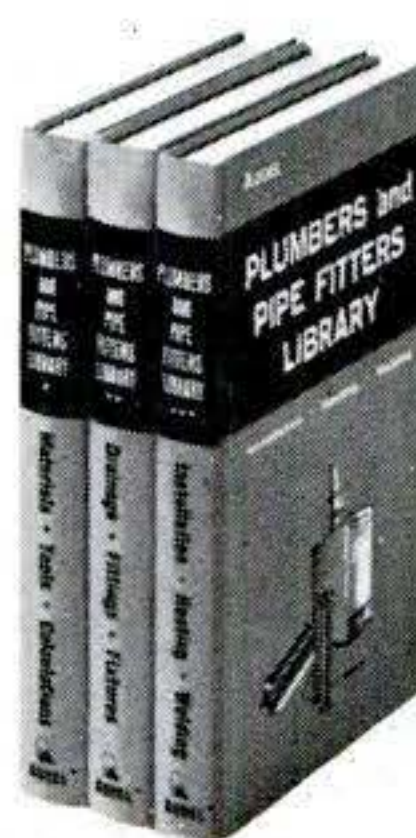
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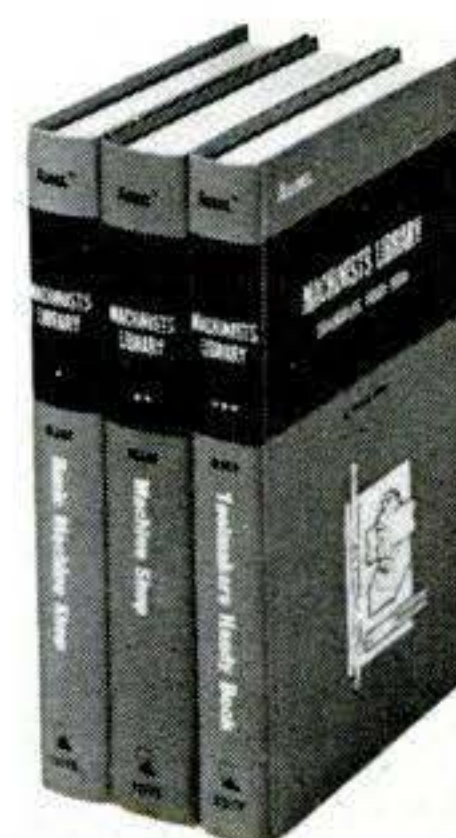
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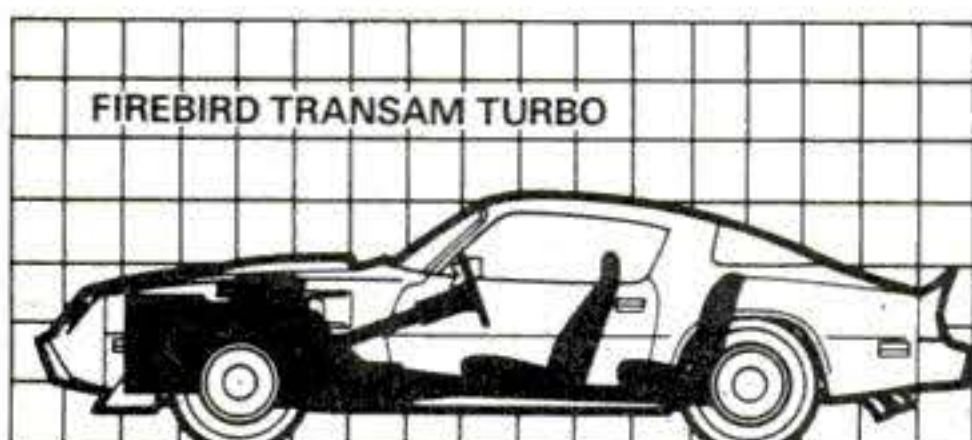
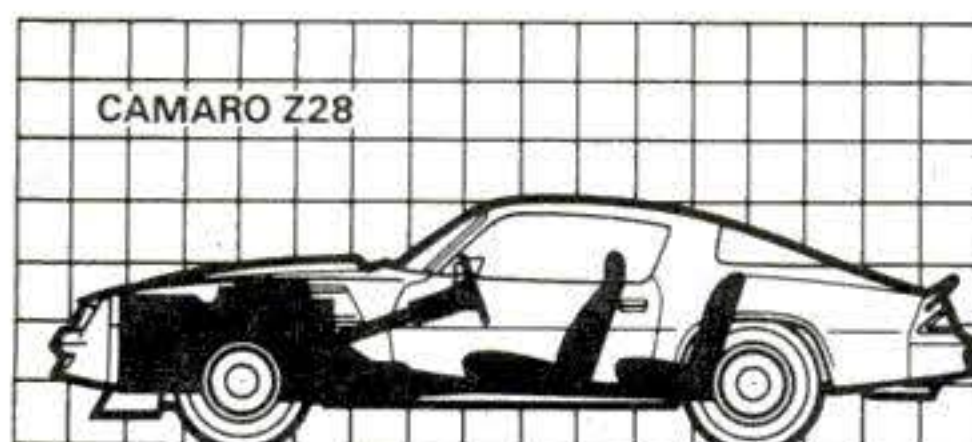
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Sweeping curves and long, low look of classic sporty cars like Chevrolet Z28 Camaro (top) and Pontiac Firebird TransAm Turbo (bottom) contrast strongly with compact, angular lines of Ford Mustang Cobra Turbo's contemporary design (center). Camaro and Firebird designs will soon be changed, however, to meet the changing energy picture.

PS serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

Checking fluid levels:

Battery
Master cylinder
Windshield washer
Engine oil
Coolant

Checking the engine:

Spark plugs
Distributor
Carb adjustment
Oil filter
Oil fill

Replacing hoses:

Upper radiator hose
Lower radiator hose
Heater hoses

Changing bulbs:

Headlights
Taillights
Front running lights
Front parking lights
Front directionals
Rear directionals
Rear running lights

Checking fuses

Spare-tire accessibility

Changing belts

*sealed

	Camaro Z28	Mustang Turbo	Firebird Turbo
Checking fluid levels:			
Battery	5	5	5
Master cylinder	4	4	4
Windshield washer	5	5	5
Engine oil	2	1	2
Coolant	5	5	5
Checking the engine:			
Spark plugs	1	1	1
Distributor	2	1	2
Carb adjustment	*	*	*
Oil filter	3	1	2
Oil fill	2	2	1
Replacing hoses:			
Upper radiator hose	4	4	4
Lower radiator hose	3	3	3
Heater hoses	1	3	1
Changing bulbs:			
Headlights	3	3	3
Taillights	3	2	3
Front running lights	3	3	3
Front parking lights	3	3	3
Front directionals	3	3	3
Rear directionals	3	2	3
Rear running lights	3	2	3
Checking fuses	4	2	4
Spare-tire accessibility	3	3	3
Changing belts	4	3	2

Performance comparison with selected 1980 and earlier models

	Mpg (city driving)	Acceleration 0-60 mph (sec.)	Brakes 60-0 mph (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1979 Ford Mustang Turbo 4	21	11.7	172	64.7	30.6	74
1979 Pontiac TransAm V8	14	10.5	146	62.4	29.1	71
1979 Chevrolet Camaro Z28 V8	16	10.4	156	60.0	29.1	73
1978 Ford Mustang V8	16	14.0	183	60.0	29.1	74
1978 Pontiac TransAm V8	15	9.5	139	62.4	29.1	73
1978 Chevrolet Corvette V8	14	9.4	145	64.7	30.6	76
1980 Porsche 924 Turbo 4	19	9.7	125	62.4	31.1	72
1980 Mazda RX-7 2-rotor	17	10.5	137	64.7	31.1	74

Camaro Z28, Mustang Turbo, and Firebird Turbo-- dimensions, specs, and test results

	Camaro Z28	Mustang Turbo	Firebird Turbo
DIMENSIONS (inches)			
Wheelbase	108.0	100.4	108.2
Overall length	197.6	179.1	198.1
Overall height	49.2	51.5	50.3
Overall width	74.5	69.1	73.0
Track, F/R	61.3/60.0	56.6/57.0	61.3/60.0
Ground clearance	6.3	6.2	6.8
Front head room	36.9	37.2	37.2
Front hip room	55.3	54.0	55.3
Front leg room	43.9	40.9	43.9
Rear head room	35.7	35.9	36.0
Rear hip room	46.3	46.6	46.3
Rear leg room (min.)	28.4	29.8	28.4
Rear knee room (min.)	-2.5	-1.1	-2.5
Coupe distance	27.3	28.2	27.3
SPECIFICATIONS			
Engine type	V8	I4 Turbo	V8 Turbo
Displacement (cu. in./L)	350/5.7	140/2.3	301/4.9
Compression ratio	8.2:1	9.0:1	7.5
Carburetion	4-bbl.	2-bbl.	4-bbl.
Net hp @ rpm	190 @ 4200	132 @ 5500	210 @ 4000
Net torque @ rpm	280 @ 2400	142 @ 3500	345 @ 2000
Transmission	Four-speed manual	Four-speed manual	Three-speed automatic
Axle ratio	3.08:1	3.45:1	3.08:1
Tire make	Goodyear	Michelin	Goodyear
Tire type	Polysteel Radial Custom	TRX radial	Polysteel Radial Custom
Tire size	P225/70R15	190/65HR390	P225/70R15
Steering	Recirculating-ball, power	Rack and pinion, power	Recirculating-ball, power
Overall steering ratio	13.0:1	Variable 20.0-16.0:1	Variable 16.5-14.3:1
Turns, lock to lock	2.61	3.40	2.41
Turn diameter (ft.)	38.5	37.2	38.5
Front suspension	Independent, single lower control arms, coil springs	Independent, hybrid MacPherson strut	Independent, single lower control arms, coil springs
Rear suspension	Solid axle, Salisbury, multiple-leaf springs	Solid axle, four control links, coil springs	Solid axle, Salisbury, multiple-leaf springs
Front stabilizer-bar diameter (in.)	1.13	1.12	1.25
Rear stabilizer-bar diameter (in.)	0.63	0.50	0.75
Trailer towing (max. lbs.)	1000	Not recommended	Not recommended
Trailer tongue weight (max. lbs.)	100	Not recommended	Not recommended
Brakes	Disc/drum, power	Disc/drum, power	Disc/disc, power
Brake swept area (sq. in.)	326.4	250.0	n.a.
Fuel tank (gal.)	21.0	12.5	21.0
Trunk space (cu. ft.)	7.1	12.0	7.1
Liftover height (in.)	27.6	29.4	29.1
Curb weight (lbs.)	3500	2697	3520
F/R weight distribution (%)	54/46	57/43	56/44
Basic price	\$7189	\$5122	\$7178
Price as tested	\$9567	\$6620	\$9960
Major options on test car	A/C \$566, deluxe interior \$353, rear defroster \$107, aluminum wheels \$257, AM/FM stereo tape \$285	A/C \$538, accent group \$120, console \$166, power locks \$113, AM/FM stereo \$183, sunroof \$204, power steering \$162, Cobra package \$1482	A/C \$566, hood decal \$120, turbo V8 \$350, cruise control \$112, rear defroster \$107, power windows \$143, AM/FM stereo \$192, performance package \$481, custom interior \$187

TEST RESULTS

Acceleration (sec.)			
0-60 mph	9.9	13.4	11.3
25-70 mph	10.9	16.6	13.4
Brake test (cool) 60-0 mph			
Stopping distance (ft.)	161	179	179
Pedal pressure (lbs.)	139	80	200
Brake test (hot) 60-0 mph			
Stopping distance (ft.)	177	165	160
Pedal pressure (lbs.)	178	100	160
Interior noise @ 60 mph (dBA)	74	77	74
Handling test (mph)*	60.0	62.4	60.0
Maneuverability test (mph)*	27.6+	27.6+	27.6+

*Safety considerations have dictated a change in our track-testing procedures. If a car is capable of exceeding our minimums for a "5" rating in either the slalom (maneuverability) or high-speed lane-change (handling), further testing for higher speeds will not be performed. Test results printed 27.6+ and 65+, respectively, will indicate this has occurred.

AM stereo — FCC approves a system

AM radios are due for a major overhaul now that the FCC has decided broadcasters may begin transmitting in stereo, using a system designed by Magnavox.

The idea of AM stereo isn't new. Magnavox, Belar, Harris, Motorola, and Kahn submitted prototype systems to the FCC years ago. What took so long? Incompatibility.

The basic idea behind AM is similar to FM stereo: Two audio channels are coded and sent as one signal by a broadcasting AM station. Once received by your radio, a decoder circuit splits them up again into two channels of audio—one for each speaker.

The problem, however, has been that none of the systems is compatible with any other. A signal coded by the Belar system cannot be used by a Harris-circuit radio, for instance.

If the FCC had simply let broadcasters use whichever system they chose, you'd need a radio with four decoders to be sure of getting stereo sound. It would not only mean more expense, but a possible recurrence of the four-channel mixup for manufacturers.

The result has been a four-year wait. But the payoff is a single system chosen on merit, not politics. In its decision, the FCC considered technical criteria such as: adjacent-channel interference, spurious emissions, and omnidirectional properties. Also, the system had to be compatible with existing radios. Your present AM radio will receive the stereo broadcast as a monophonic signal.

The frequency response of an AM stereo radio can theoretically be comparable to FM. Since it does not require line-of-sight transmission, however, AM stereo has an advantage over FM, especially for car use.

Prices for future radios have not been announced, and major manufacturers I spoke to all gave the same timetable: "It's in the works." Which means sometime next year.

Even if you own a radio, it may be some time before you actually begin receiving an AM Stereo broadcast. It will depend on where you live. Small AM stations that are not yet equipped to handle stereo will need major changes.

For larger stations and national networks, the transition could come swiftly. "You can try to reach our director of engineering," said a manager for NBC on the day of the FCC decision, "but he's pretty busy right now."—*W. J. Hawkins*

Bruce Dutton, How long do you want your Saab to last?

"I've driven over 180,000 miles between my Saab and my Fiat, all on Quaker State and no problems yet. My two cars have small 4-cylinder engines. A motor that size has to work pretty hard, and I find that Quaker State really does a job on helping these little cars last.

"I've been using Quaker State 26 years. I started with my first car back in 1953.

"I was brought up in Pennsylvania around the oil industry. Quaker State was the big motor oil back there. My father used it, he handed it down to me and I've had excellent results.

"It's a great product. I've been able to put over 100,000 miles on my old Saab without so much as a valve job and the car still, to this day, doesn't need oil between changes.

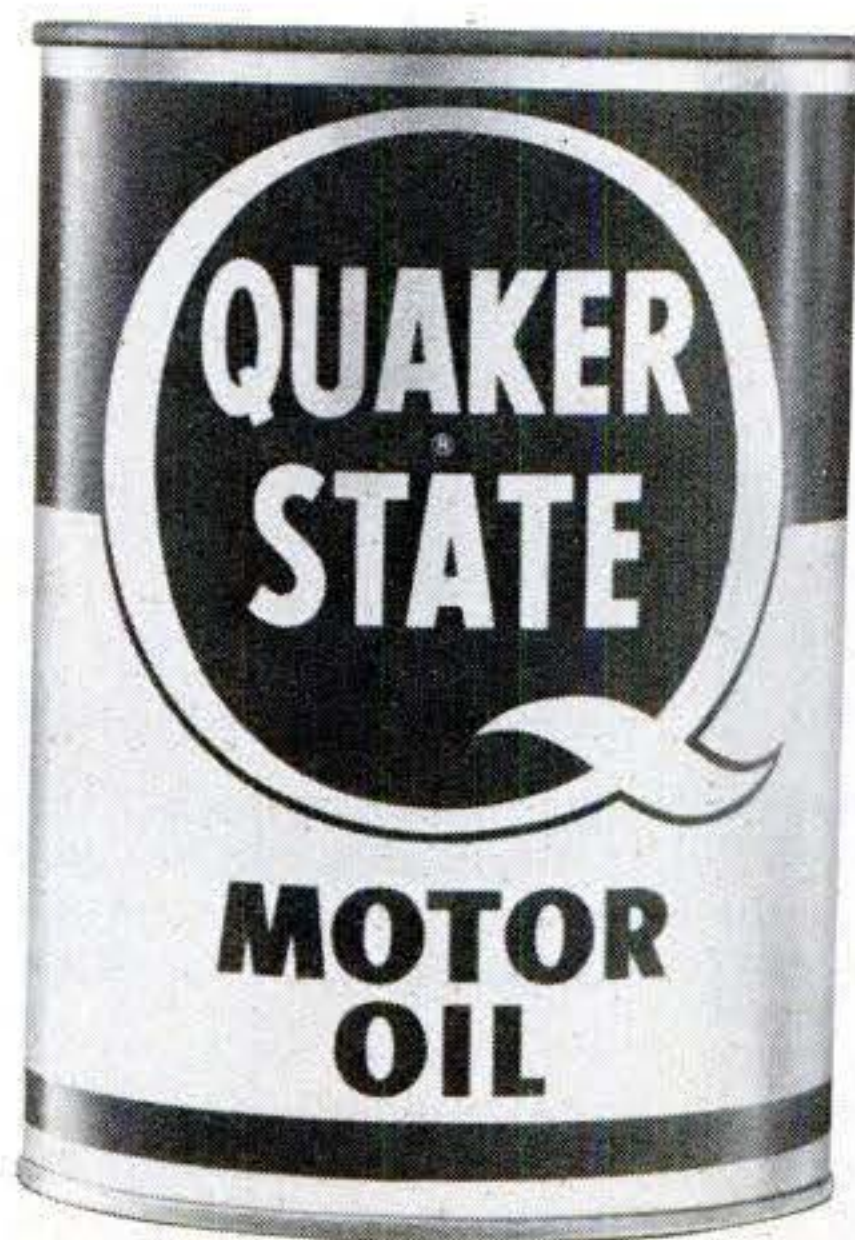
"At the present time we have four automobiles in the family, two Saabs, the Fiat and a Dodge. The tune-up work is done by the dealerships, but as far as the lubrications and oil changes go, I do that myself. The rare thing about it is the oil keeps coming out clean. I've



really been impressed with the way Quaker State seems to add life to my cars.

"Almost all my automobiles have run well over 100,000 miles and the ones that haven't done it yet, I figure they will. All it takes is regular service and Quaker State Motor Oil."

—Bruce Dutton, Seminole, Florida



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Hot flashes

from the
photo show

By EVERETT H. ORTNER

The revolution in electronic-flash units continues, as the Photo Manufacturing Assn.'s spring show of new equipment demonstrates. Rollei's new units have gone digital, and more: They can operate, with ASA 100 film, in automatic at every stop from f/1.4 to f/16. As many as nine Olympus T-series flash units can be controlled by the sensor in one camera. Sunpak is challenging the "dedicated" flash units of camera makers—units designed to work with the electronics of their cameras. And many of today's flash units swivel and bounce—in fact, do just about everything but bump and grind.

PS



Digital readouts come to electronic flash in two new Rollei automatic units, which incorporate calculators. You set film speed and f-stop by pressing a button, which starts the display changing, and releasing it at the right setting. The unit then displays maximum shooting distance (left). Beta 5 (guide number 112 with ASA 100 film) is \$182.50. Beta 6 (GN 125) is \$275. An optional bracket for the Beta 5 is shown above with remote sensor in the camera's hot shoe. It controls exposure regardless of flash angle.



Built-in bracket folds into Bauer E 436, which also features a swivel-and-bounce head, thyristor circuitry with three-stop auto exposure, GN 120 (ASA 100). \$160.



High-technology Sunpak Auto 522 has dedicated sensor that slips into hot shoe of electronic cameras to actuate dedicated systems. GN 120 (ASA 100). Price: \$230.



TTL OTF Olympus flash is controlled by through-the-lens off-the-film light sensor. T-32 flash (above right) sets up LED viewfinder display in OM-model cameras that shows when flash is ready and when exposure is correct, even for multiple flash. At right, T-10 ring flash and macro lens for close-ups are linked to T Power Control.





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Tough '80 Fords give you more payload capacity than last year's models with comparable GVWR's. Exclusive Twin-I-Beam front suspension. Aerodynamic styling. A choice of models that includes 4x4's with independent front suspension, rugged new Six-Wheeler, roomy new SuperCab.

For a tough, full-size pickup with gas mileage that rivals the best-selling import, see your Ford Dealer now!

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19

EPA
EST.
MPG*

29

EPA
EST.
HWY.*

Standard 4.9L (300 CID) Six with optional overdrive transmission.

LONGEST RANGE

722

EST. MILES

1,102

HWY. MILES

Std. 72L (19-gal.) tank plus optional 72L (19-gal.) auxiliary tank (on LWB Stylesides only). Total: 144L (38 gals.).



All-new cab interior. More leg room than last year. New instrument panel. New anti-theft features like locking steering column, inside hood release. New options include AM/FM stereo with 8-track or cassette player, underhood tool box.

*EPA estimates. Compare these estimates with others. Your mileage and range may differ depending on speed, distance and weather. Actual highway mileage and range will probably be less than estimated. California estimates lower. Diesels and car-trucks excluded.

**America's best-selling pickup
for the 3rd straight calendar year.**

Based on 1977-79 calendar year retail deliveries.



FORD

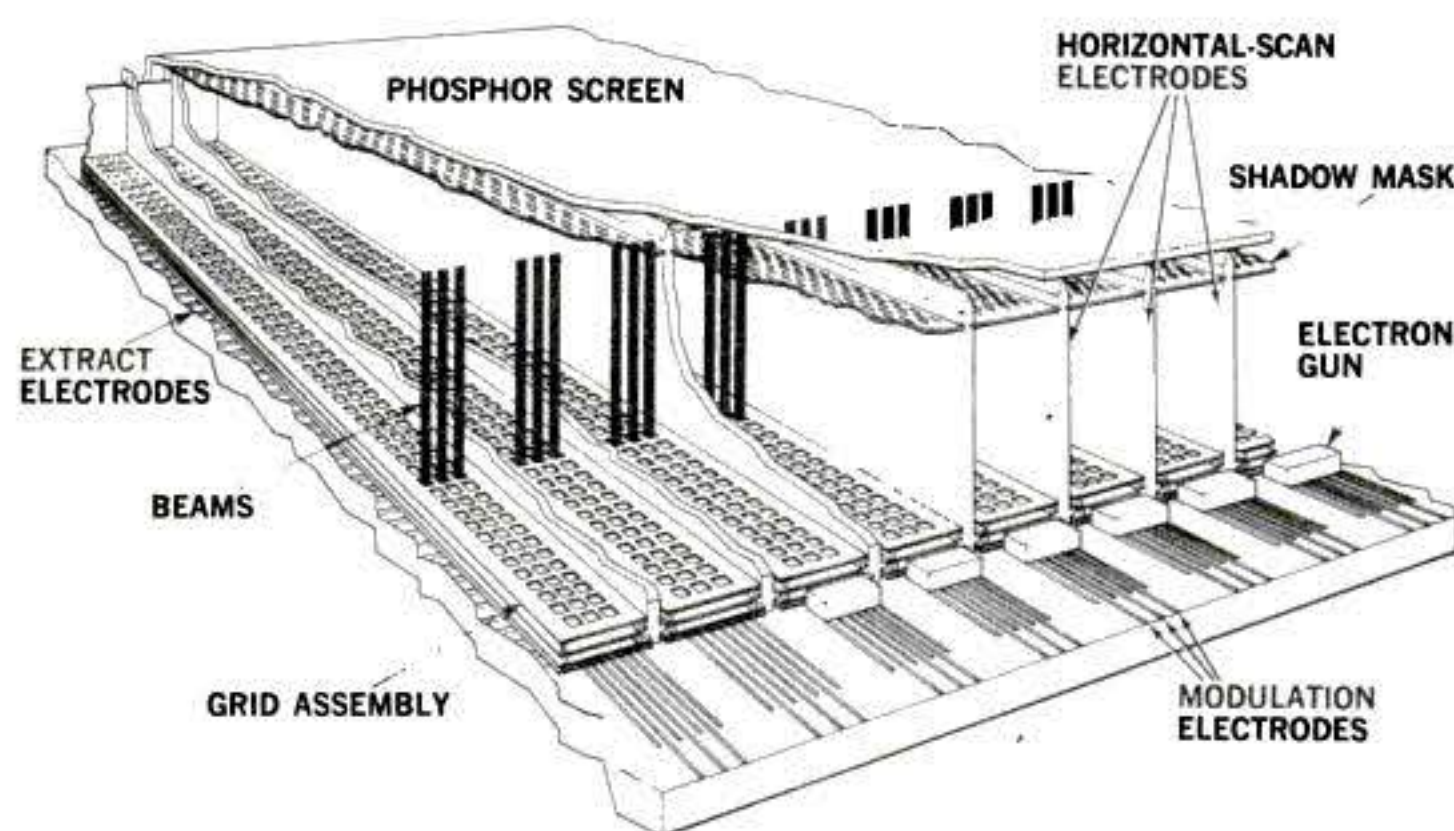
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LOOK AND LISTEN

By JOHN FREE



RCA's flat-screen TV

Will future hang-on-the-wall, flat-screen TV's use thin-film electroluminescent, liquid-crystal, LED, or plasma technology? All of them, perhaps, but a tour I made of RCA's research labs suggests its models will have greatly flattened versions of the familiar shadow-mask color picture tube.

RCA has experimented with most flat-screen technologies during the past 35 years. Researchers concluded that cathodoluminescence—bombarding phosphors with electrons—is a tough display technique to beat in performance and cost. So RCA is concentrating on making a 50-inch-diagonal vacuum tube that's only about four inches thick. A satisfactory flat-screen tube and set should be ready in the mid-to-late 1980's.

One current RCA flat-panel design is shown above on its back. TV signals modulate beams from the electron guns (cathode) that travel upward into 40 one-inch-wide modules, each 30 inches high. Extract electrodes pluck off one TV scan line at a time, and the beams are bent 90 degrees through grids, a shadow mask, and onto red, green, and blue phosphors. Instead of coils (a picture-tube yoke), horizontal-scan electrodes, spaced one inch apart, deflect the electron beams electrostatically.

A small test panel, about five percent of the final screen area, was undergoing a modification when I visited. A video-cassette tape showing this panel in black-and-white operation indicated it has fair picture contrast, but made it clear there's a lot of work remaining. RCA expects that brightness and detail will eventually match today's sets.

Video-disc recorder

Elsewhere, in a tiny basement lab, RCA researchers demonstrated an optical video-disc recorder under development. It

works like the playback-only machines being test-marketed by Magnavox and Pioneer ("Video-Disc Players," this issue), but in addition can record one hour of video on a side.

RCA's lab recorder has a special solid-state laser that operates at 40 milliwatts to "burn" some 100 billion bits of on-off information onto a

disc—enough storage capacity for a complete *Encyclopædia Britannica* set. The laser runs at low power to "read" information back. To demonstrate its capability, a researcher "grabbed" a few TV frames off the air, freezing a quiz-show contestant in mid-applause.

RCA executives said the recorder will be made for the broadcast industry, computer-data storage, and other institutional use rather than for the home. N. V. Philips (of Holland), key developer of the Magnavox disc player, is working on a disc recorder, too, as are others. A big advantage of such machines, if introduced for home use, is that blank discs can be stamped out for pennies, compared with costly videotape cassettes.

Quick looks

- Boosted color fidelity in TV pictures may be here soon as set manufacturers adopt newly patented circuits from Quadricolor Technology (Great Neck, N.Y.). Inventor Donald Richman, who helped devise the compatible black-and-white/color TV system used in the U.S. and Japan, says his circuits dramatically improve picture quality by correcting components of the red, green, and blue color signals.

- High Com, a noise-suppression system pushed by Telefunken GmbH, should be turning up in hi-fi components. Over a dozen U.S. audio firms and many other foreign companies have received High Com licenses from Telefunken. The signal-processing technique works something like Dolby, but delivers 20 dB instead of 10 dB noise suppression. It also works on the entire audio spectrum instead of only high (tape-hiss) frequencies like Dolby B.

- Buyers in Japan can pick up a \$1500 Hitachi color TV receiver that displays a second color TV picture within the main picture. Most sets with this feature display a black-and-white secondary picture. Digital memory circuits make it possible to

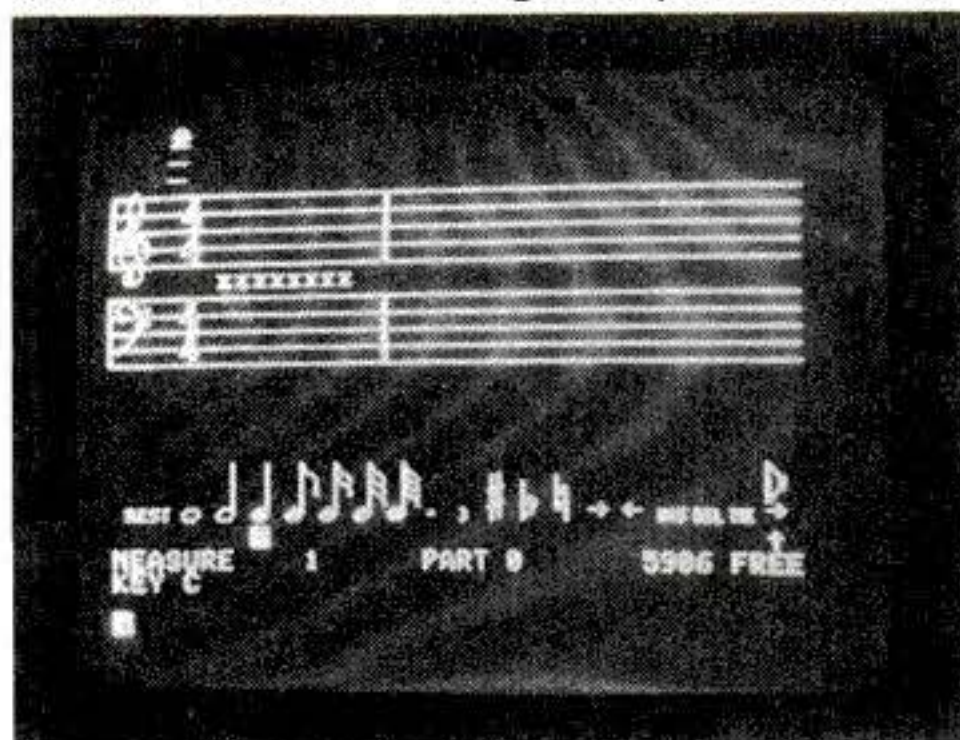
shift the smaller picture around, or freeze the main picture electronically. Officials at RCA Laboratories said recently that low-cost microcircuits in future TV's will routinely convert off-the-air signals into a digital format for image enhancement or more complex manipulation of home-screen images.

- The Communications Satellite Corp. (Comsat) wants to develop a satellite-to-home TV service, supplementing commercial programs with perhaps six additional channels. A recent FCC study says that by 1990 satellite broadcasts to small home antennas will be commonplace.

Discs: 45-rpm LP's, magnetics

Disco fanciers may be familiar with the wider dynamic music range on 12-inch LP discs cut for 45-rpm play instead of 33 $\frac{1}{3}$. How about classical music on 45-rpm LP's? One of Angel's 45 Sonics Series I tried recently (SS-45011, made by Capitol Records Inc.) had perceptibly better high-level peaks and frequency response, but an appalling amount of low-level noise. The noise might have been caused by poor-quality plastic or the cutting itself, rather than the souped-up speed. But discs in this series don't have a disco beat masking background noise, so a test before you buy is in order.

Hi-fi discs with noiseless super-fidelity music stored as digital pulse-code-modulation signals [PS, March '78] may be years off. But I've been listening to a closely related form of music played from 5 $\frac{1}{4}$ -inch magnetic discs that store digital data for an Apple II computer. ALF Products Inc. (1448 Estes, Denver, Colo. 80215) makes a plug-in music-synthesizer board for the Apple. A computer-graphics display for the board (photo) lets you create or copy music by shifting symbols around on a TV screen with game paddles, stor-



ing data in memory. (I'll describe the hardware, plus a plug-in standard organ keyboard, in a future issue.)

How was the music from some ALF discs? It sounds something like a harpsichord, and is delightfully noise-free. Music selections, run as computer programs loaded from three discs, ranged from brief classical works and Christmas and other popular songs to clever pieces devised by ALF's software experts.

I piped the computer's video into my projection TV and watched colored squares appear and disappear for each note and part. I ran two boards, each generating three parts. Other firms are introducing similar boards that can generate still more realistically synthesized sounds.

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PS | What's News

For many years, Jan Norbye was auto editor of POPULAR SCIENCE. Five years ago he decided to return to his native Europe and report on the automotive scene from there. Over the years, his well-developed network of contacts in the European automotive world has produced a number of exclusive stories, including the article on the Jarret rectilinear engine last month.

Now, Jan has uncovered yet another exclusive. The giant Volkswagen company, known for its innovative approach to automotive design, has been quietly redesigning the automobile to take into account today's reality: a world progressively shorter of fuel.

The car, called the VW 2000, presumably depicts what VW thinks cars will look like by the turn of the century and contains many original features. While the basic vehicle is about the size of a Rabbit, it should be far lighter and will incorporate advanced aerodynamic modeling to cut down on drag. It also contains radically different construction features. But perhaps its most striking feature is a novel two-clutch flywheel transmission. With this arrangement, the engine stops when you lift your foot from the gas. At the same time, the engine is disconnected from the drive shaft. When you press on the accelerator, the proper clutches are automatically engaged, the spinning flywheel starts the engine, and you're accelerating in one-tenth of a second.

While VW is implying that a car containing all of the advanced features of the vehicle now under study would not be on the road for 20 years, I'm betting that important elements will start appearing long before that. Advanced aerodynamic design, for example, is already becoming more important [PS, Nov. '79], lightweight materials are receiving more study [PS, April '79], and many companies including American car makers are looking into automatic stop-start systems, since it's obvious they can save a lot of gas in stop-and-go driving.

While the VW 2000 design is simply a series of advanced concepts that will probably never appear exactly as they are now conceived in a single car, it is nevertheless an important step toward the ultimate development of the car of the future. We thought it important enough to put on our cover, and commissioned artist Pierre Mion to do the painting. Jan's story starts on page 76.

Stop-start: another approach

You may remember that just one year ago last month we reported on three car computers in our cover story. One was made by Zemco, Inc. A few months after that Zemco called with the news that it had developed another item: an add-on stop-go device. In this issue you'll find Paul Bolton's report on the Fuel Saver, written after using it in New York traffic.

As this issue went to press, we heard that the California Air Resources Board had concluded its tests on Zemco's device. The result: a nine percent improvement in mpg in the EPA urban driving cycle. Emissions were also lower than in the base-line test. The CARB results constitute official approval for use of the device in California and can be used in promotional material by the company.

Fuel-cell progress

About the time you read this, the nation's first fuel cells destined to go into actual operation in a power plant are scheduled to be installed in Consolidated Edison's East River Generating Station in New York City. By early next year, they will be pumping almost five megawatts of electricity into the city's power grid.

Fuel cells are essentially batteries that convert chemical energy into electrical energy [PS, March '77]. They differ from regular batteries in that fuel can be fed in continuously so they can operate indefinitely. Fuel cells operating on hydrogen and oxygen generated electricity for the Apollo flights to the moon. The units that will soon be operating in New York use methane or naphtha.

Fuel cells are attractive because they produce little or no air pollution, have no moving parts, make no noise, and could be put to work quickly where needed. A plant could be built in perhaps two years, for example, instead of eight to 12 as with more conventional power plants. But the overwhelming reason work continues on fuel cells is that they promise to convert the potential energy in fuel to electricity with an efficiency of up to about 55 percent, instead of the 32 percent or so of conventional steam plants.

The cells going into the New York station, built by United Technologies, are of the phosphoric acid electrolyte type. They'll be only about 37 percent efficient,

but will give engineers the operating data they need for the future. Another type that operates at higher temperatures and pressures and uses a molten carbonate electrolyte could give higher efficiencies, but needs more development.

Briefly noted

- Sandia Lab is testing a new steam generator designed to recover heavy crudes [PS, Dec. '79] from depths too deep to be practical by current methods. Today, crude oil too viscous to flow can be heated by steam piped down from the surface. The heated oil is thinner and can be pumped out of holes surrounding the steam-injection hole. The technique can't be used at depths greater than about 3000 feet, because the steam cools too much on the way down. The new generator works at the bottom of the hole, with propane and high-pressure air pumped down to it. Thus it can work at any depth. It also uses less fuel, since the steam is delivered at full temperature and doesn't have a chance to cool off on the way down.

- Union Oil has announced that the first commercial-sized plant designed to extract oil from shale will be under construction soon. The project in western Colorado will initially produce 10,000 barrels of oil a day.

- Want to guess what the latest shortage concerns? NASA says it's communications satellites. By the 1982-83 period, the space agency predicts, we'll have about 200 transponders in orbit. A transponder is the receiver-transmitter that relays a signal to its destination. A Western Union study predicts that by the year 2000 we'll need 2000 transponders in space, enough to handle 25 percent of all long-distance voice communications and 50 percent of all data and video traffic. The problem: With the Space Shuttle running behind schedule, there may not be enough launch capacity to get that many transponders in orbit in time.



Editor-in-Chief

Smart new detectors

probe and identify hidden material

Weak electric and magnetic fields spot guns, dope, and explosives

By **LEE GREATHOUSE**

DRAWINGS BY BUONOCORE STUDIOS

Bill Gregory, a physics professor at Georgetown University in Washington, D.C., slipped a letter-size envelope into a slot of a three-foot-wide, foot-high box. Nothing happened. Security agents from the U.S. Air Force, CIA, and Secret Service watched closely.

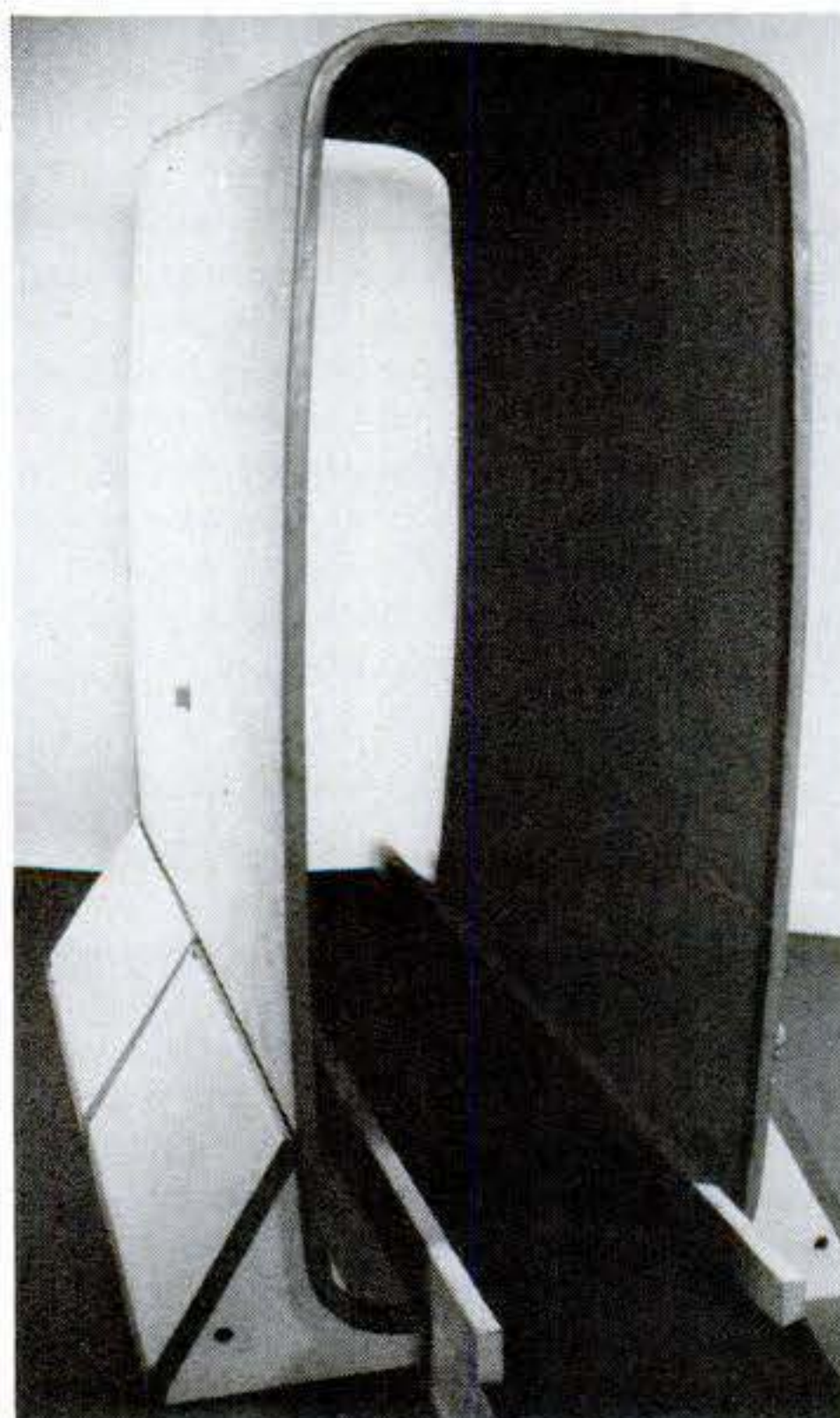
Gregory picked up another envelope and placed it in the slot. Yellow panel lights snapped on. A buzzer sounded a warning. The first envelope contained a thin bundle of cut paper; the second, a strip of plastic explosive and a deactuated detonator.

The government agents were looking at a new breed of letter-bomb detector. These supersensitive machines probe packages with electric and magnetic fields at audio frequencies and harmless levels of a millionth or billionth of a watt. The detectors measure the unique "signatures" of objects from their electrical properties. By comparing the results with previous measurements stored in an electronic memory, the detectors can distinguish between different types of explosives, concealed narcotics, and even identify the make and caliber of a hidden gun.

But the principles involved extend beyond the security field. Other areas where the techniques might be used:

- Machines that would see inside the human body to pinpoint cancer tumors without hazardous X-rays.

- Metal detectors to aid in the identification of scrap metal or to



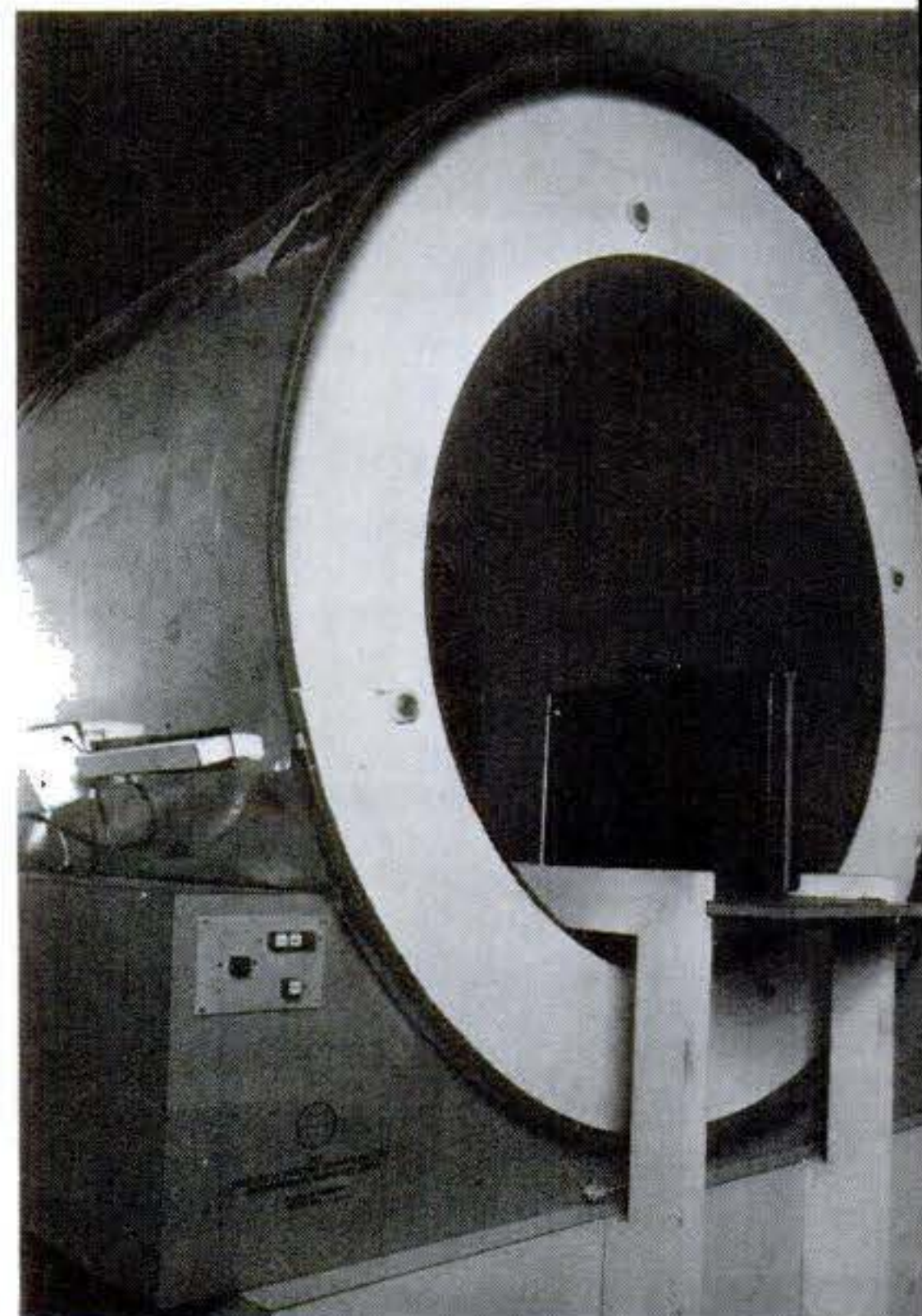
Walk-through detector can spot lead (nonmagnetic) to prevent smuggling of material from nuclear plants.

help in the location of buried ore.

- Quality control of welds, alloy content, or carbon-filament epoxy—the supertough steel substitute.

Molecule sniffers

Bomb detectors and other devices employing this relatively new technology are being developed and marketed by Detection Systems Technology (DST) of Merrifield, Va., through a Georgetown University program aimed at putting research studies to practical use. Gregory, on temporary leave from Georgetown to serve as DST's technical director, explained that the new detectors have advan-



Package tester built for United States Information Agency probes case for pipe and battery indicating a bomb.

tages in simplicity, speed, and cost over other methods of detecting hidden objects.

X-rays, for example, require a costly high-voltage tube, plus an operator to interpret the picture. Mass screening of people at airports isn't possible because of the health hazards of X-rays. Also, bombs can be built with X-ray-triggered detonators. So-called "sniffers" that use gas spectroscopy to detect molecules of substances in the air have been used successfully by the U.S. Custom Service. But these devices have a high false-alarm rate, and don't work on metals.

Metal detectors now used in air-



ports cannot distinguish between types of metals, and guns made of some metals can slip right past.

Resistance peaks

Groundwork for the new detectors began in the mid-1960's with Gregory's graduate studies. He was researching superconductivity, the phenomenon exhibited by some metals chilled to almost absolute zero that makes their resistance to electrical current disappear. The transition to superconductivity may occur over a very small temperature range—a millionth of a degree. "We had to have a very sensitive technique to see that," Gregory said.

Into the picture came an instrument called the phase-sensitive detector (PSD), also called a lock-in amplifier. It was being used to study the tiny signals generated in nuclear-magnetic-resonance research [PS, Dec. '77]. "We got our hands on

one of the first ones," Gregory said.

To see the transition to superconductivity, a pair of metal coils is placed around the sample. An oscillator signal driving one coil induces a voltage in the second through mutual inductance. PSD's can lock in on the drive signal to eliminate signal noise and help pinpoint just when superconductivity causes a sharp drop in mutual inductance.

The PSD had a special switch on it that enabled Gregory to examine the resistance of the detector coil. But the switch produced puzzling results. "There was a [resistance] peak," says Gregory. "We really didn't know what it meant." Gregory and his co-workers tried a piece of copper, a nonsuperconductor, in the setup. The peak appeared anyway.

"We decided this had nothing to do with superconductivity," Gregory said. The researchers turned to reference books for an answer, and they

Weak electric and magnetic fields from this detector probe letters to sense the electrical properties of the contents. Explosives will trigger alarm.

found it in the pioneering equations on electromagnetics by James Maxwell. "They predicted a peak, and the peak occurs exactly where it's supposed to be," Gregory said. The peak in the detector coil's resistance is associated with the size and physical properties of the metal sample within it, he explained.

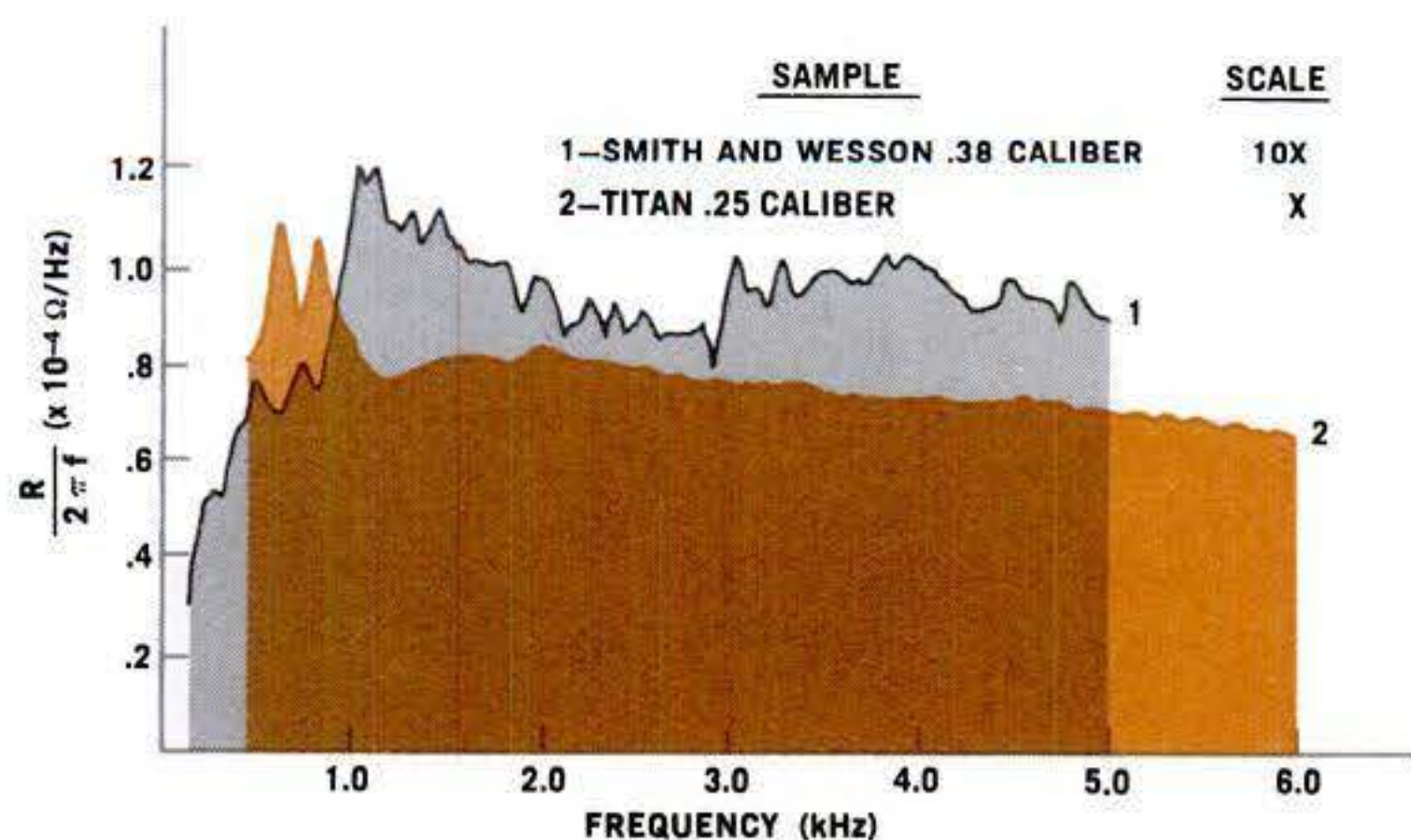
That explanation of a laboratory curiosity might have gone unused but for an oil-rich Persian Gulf emirate and its worried sheik. "The sheik wanted a good metal detector," Gregory said. "It had to be a pretty good one because it was not considered honorable to search people." He wanted a detector that could distinguish a ceremonial sword from a hidden weapon.

Although the Georgetown physicist could not solve the sheik's problem at the time, it set him thinking how the lab discovery could be applied to metal detectors. It was now the early 1970's, when minicomputers were becoming popular. "We just happened to stumble upon this just at the point in time when computing capability was becoming available cheap," said Gregory. The computers provide one means of analyzing changes in detector-coil resistance at various frequencies; these changes can also be plotted (see graphs).

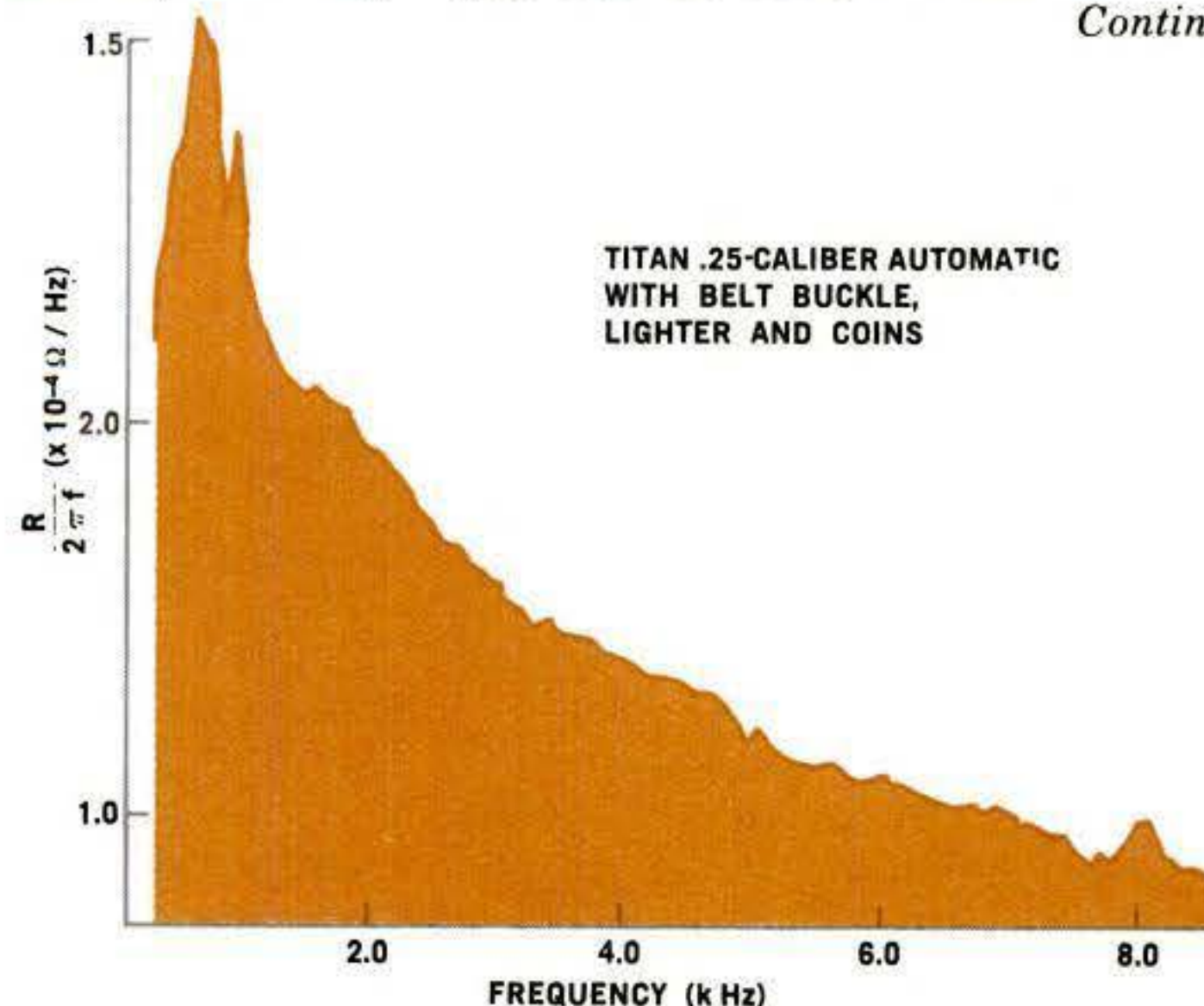
The resistance for any given piece of metal (say, a one-inch cube of aluminum) reaches a peak and then tapers off. If several pieces of metal are placed in a detector coil, each will register its own peak. And since a gun is just several pieces of metal, it creates a collection of resistivity peaks as its "signature." The signature of an object can be stored in an electronic

Continued

Telltale peaks identify weapons



Peaks in curves represent types and amounts of metal in two handguns. Vertical axes in graphs indicate resistance of a detector coil. Handguns within this coil alter its resistance as a range of



coil frequencies (horizontal axis) electromagnetically induce eddy currents in the weapons. Unique signature of Titan (right) is still detectable with added metal objects.



They substituted metal plates for coils and used a very similar frequency-sweep technique with voltages. Data on the electrical properties of explosives predicted what the signatures would be if the explosive became the dielectric (insulating) material between the plates of a capacitor. And sure enough, the signature was present. Changes in capacitance at different frequencies trace characteristic curves of explosive materials. The curves are not so distinctive as those from metals, but can identify the material examined.

Hidden bombs

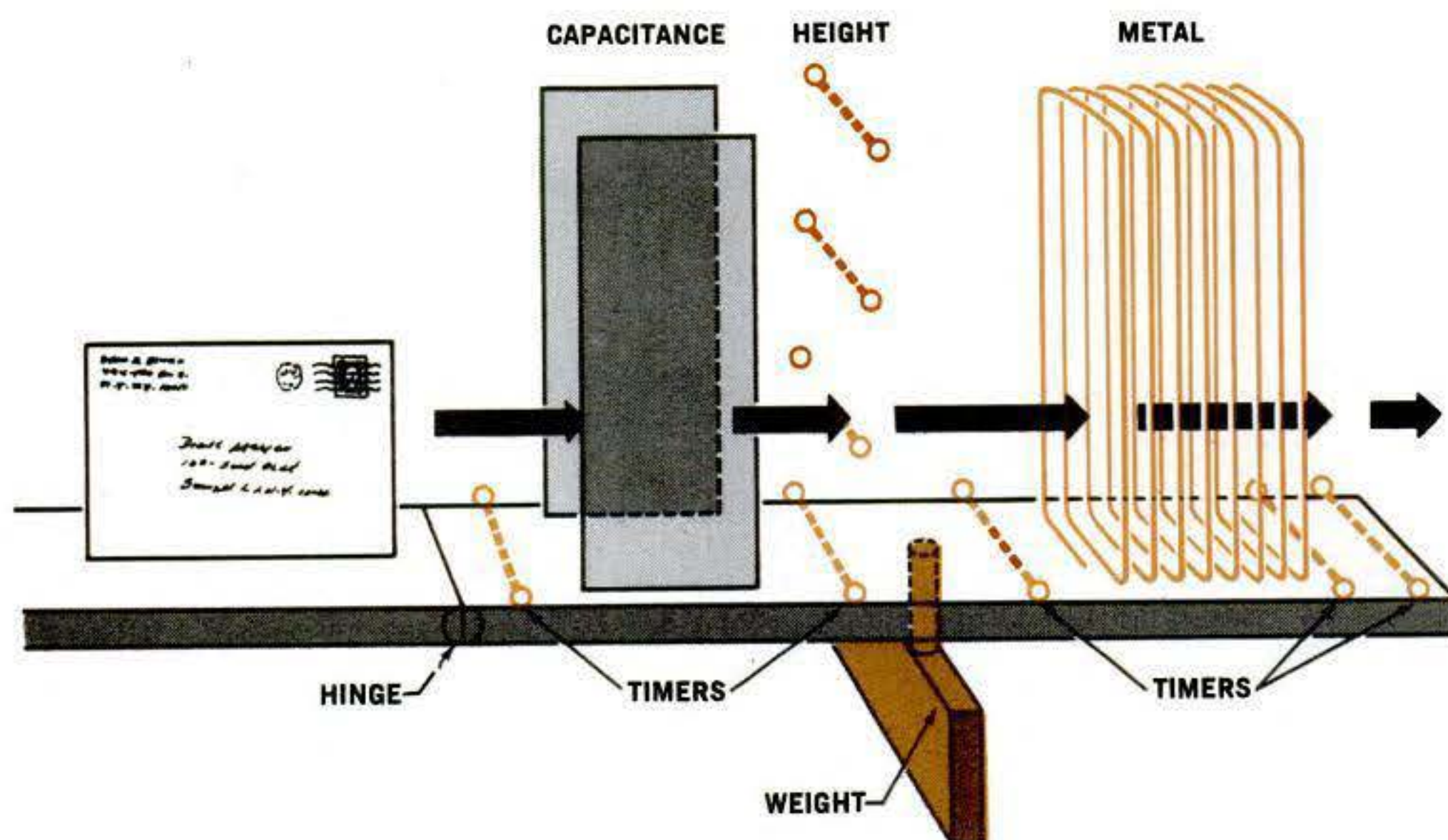
In some cases, such as a letter-bomb detector, the two systems are combined. Letter bombs usually require a detonator, such as a blasting cap and tiny battery. The metal detector adds information that helps confirm the lethal contents of a letter.

Federal and state agencies as well as foreign governments are keenly interested. A security official for one federal agency told me that, in a year of testing, one of the new-breed detectors missed none of the 20 different sample bombs put through it. The detector yielded only one false alarm.

The U.S. Custom Service has found a different application. "Our primary interest is narcotics," says John Schoolmeester, chief of its engineering branch. The devices used to sense explosives were effective and had a "very acceptable" false-alarm rate after they were put to work trying to detect cocaine, hashish, and Mexican-brown and white heroin, he said.

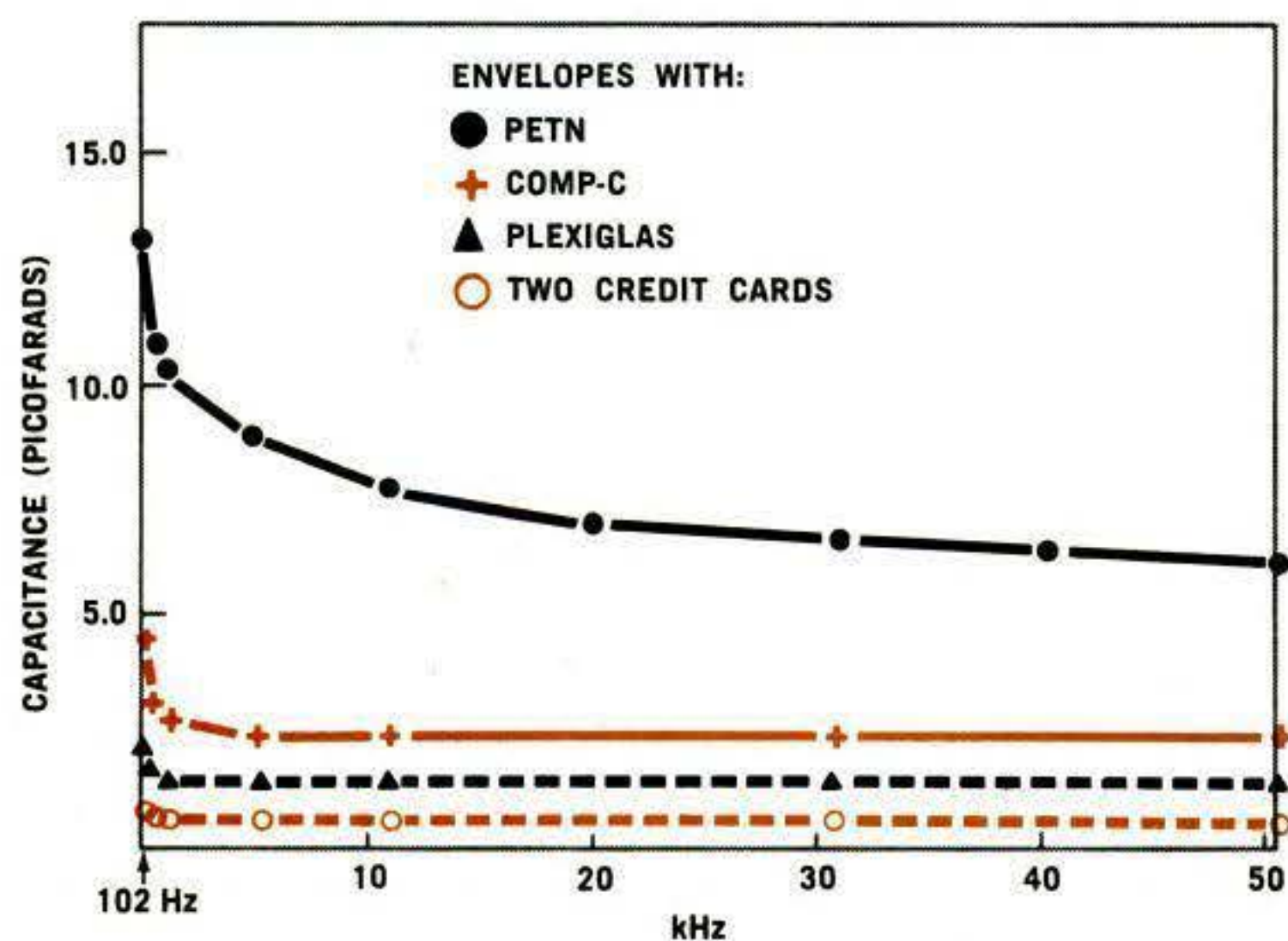
Techniques used to check millions of pieces of incoming mail at places such as New York's JFK airport aren't very effective. The ability of trained dogs to scent suspect substances fades after only an hour. Inspectors find that feeling incoming envelopes is more effective, but both techniques are very slow. "This is a gigantic step forward," says Schoolmeester on the possibility of using the detector.

The Georgetown physicists are devising and conceiving new applications, too. Experiments show the dielectric technique can check printed circuit boards in production; metal detection may be applied to nondestructive testing of weld seams. A super-cooled detection coil might look for ore half a mile underground. The harmless fields from a detector might also be applied to computerized scanners to create images of thin "slices" of the body for detecting abnormal tissue—similar to X-ray CAT scanners, but without the dangerous radiation. What began as a puzzling peak in a lab instrument may eventually turn into an important tool.



Letter-bomb detector has a series of LED's and phototransistors to register position of letters (timers) and their height. Capacitance plates are used to check for

higher dielectric properties of explosives; coil helps detect metal detonators. Letter is also weighed (hinge) to help detect explosive devices.



Dielectric constant of two explosives (plasticized PETN and Compound C) registers a higher capacitance over a range of frequencies when passed through plates of bomb detector. Similar amounts of harmless plastic have lower capacitance, and detector will not trigger an alarm.

memory, and circuits will trigger an alarm if a matching signature is ever detected again.

"We can tell you the make and the model," says Gregory, if a metal detector senses a gun in a piece of luggage. A large walk-through detector built for Sandia Laboratories was able to identify small amounts of lead that might be used to smuggle material from nuclear facilities.

During the mid-1970's, terrorist bombings were becoming a serious threat. After the 1975 bombing at New York's La Guardia airport, Gregory was asked if the detectors could identify the small amounts of metal associated with bombs. There wasn't enough metal to detect bombs consistently, but Gregory and his colleagues devised a technique to detect the explosive material instead.

The best print

From a slide?
From a color neg?

Is there an answer? PS took hundreds of pictures to test the two systems

By **EVERETT H. ORTNER**

PHOTOS BY JOHN KEATING

If color-negative film is so good, why do most professional photographers shoot transparency film—slides, in the case of 35-mm photography? Even, often, when they want prints?

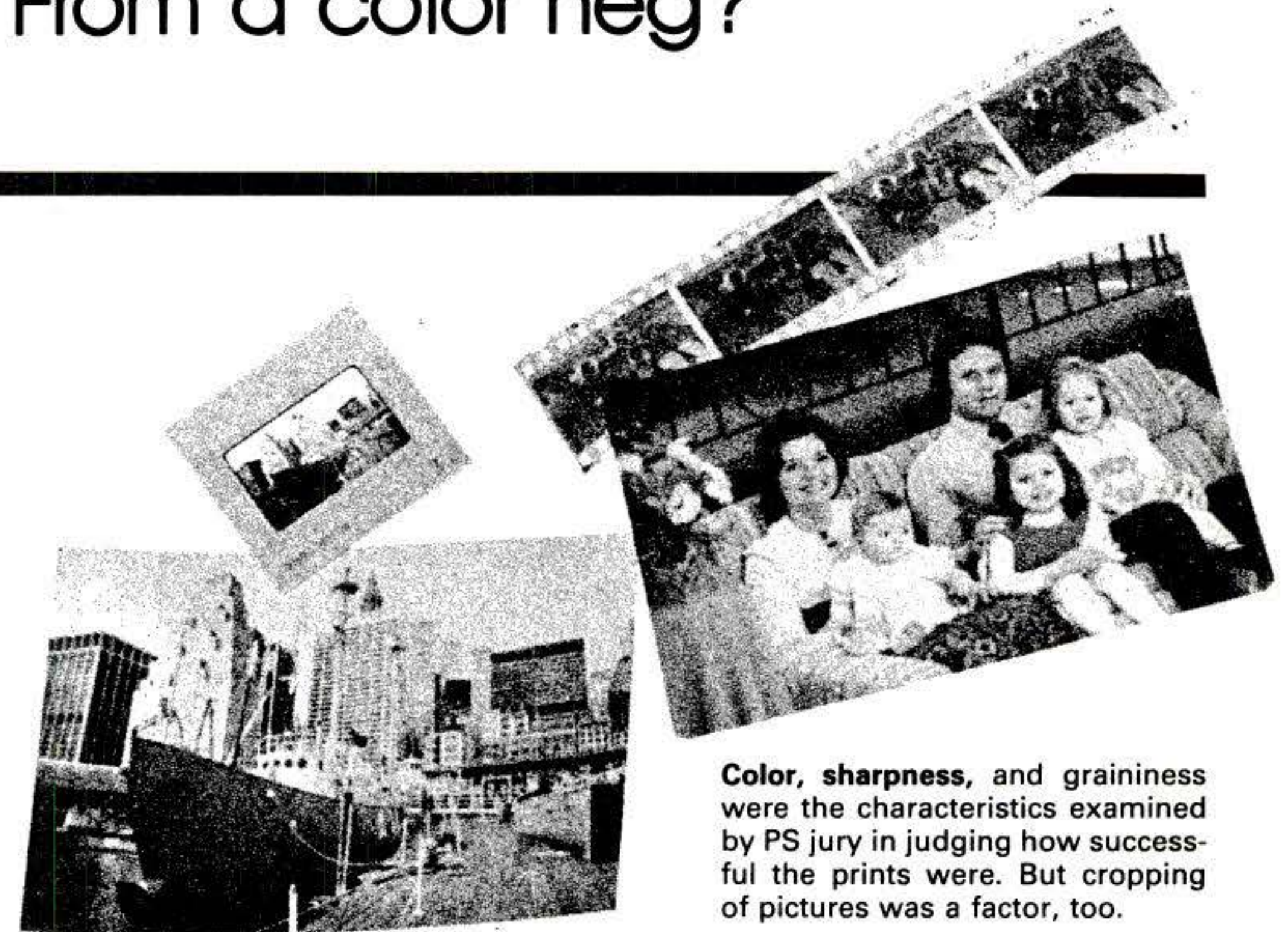
"Because," said the man from Eastman Kodak, "pros want to see a first-generation color picture rather than one that is a step away from the original subject, as a print is. Myself, I shoot Kodacolor—but then, I give most of my prints away."

"Because," said the man from Agfa-Gevaert, "pros often shoot for publication, and engravers like to make their color separations from transparencies. Also, with a transparency, the pro can accurately judge the color, sharpness, and graininess of the picture. How many people can judge a color negative? Still, in my opinion, the amateur gets a better print with negative film than he would with transparency film."

"Because," said the man from Fuji Photo Film USA, "pros need transparencies for color separations. Myself, I usually shoot Fujicolor because I get a sharper image in my prints."

We had set out to determine not whether transparency film—slide film—produces better pictures than color-negative film, but whether one of them would produce better prints for the amateur 35-mm photographer. Not the kind of prints you'd get from an expensive custom lab, but the kind you'd expect from a local camera store.

We started with prejudices. PS staff



Color, sharpness, and graininess were the characteristics examined by PS jury in judging how successful the prints were. But cropping of pictures was a factor, too.

photographer John Keating and I are slide addicts. We had a notion that we'd get better prints from slides because, we thought: (1) with a color slide in hand, we (and the processing lab) should be better able to judge the quality of a print made from it than we could with a print from a color negative; and (2) that inherently, in large-scale commercial processing, transparency film was superior in color accuracy, sharpness, graininess.

Choosing the films

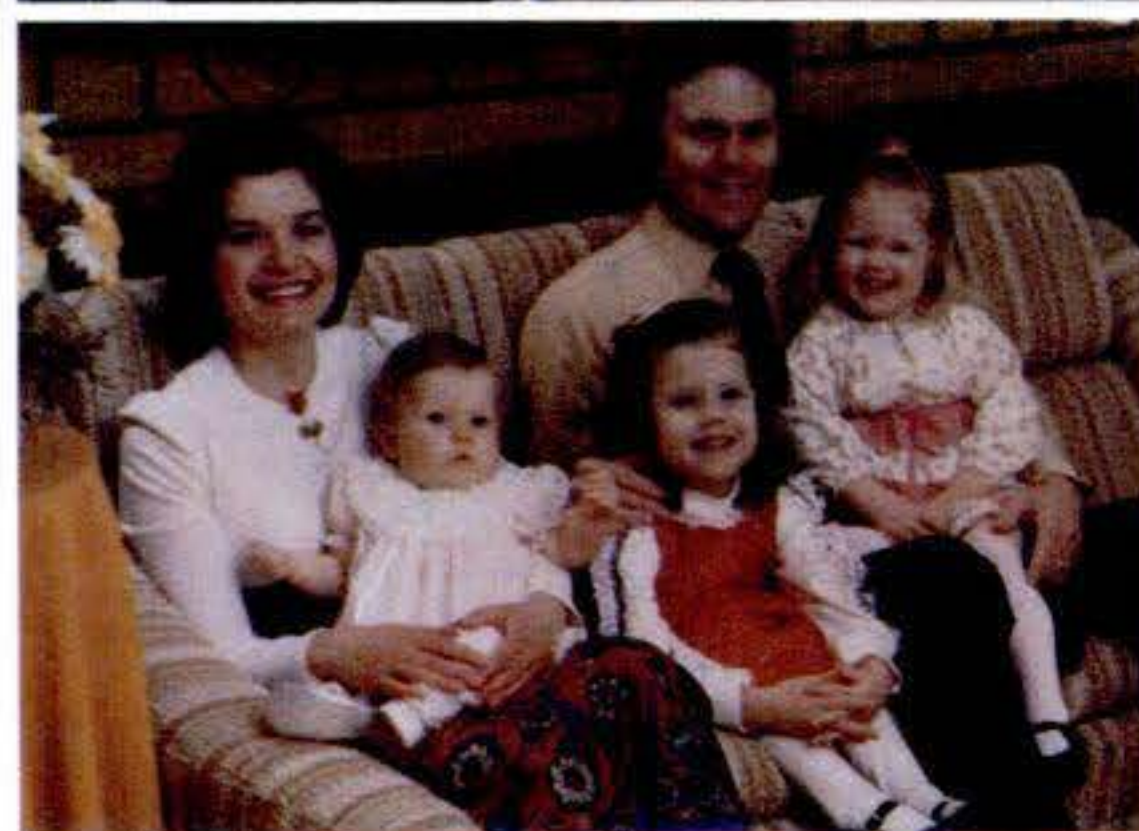
For our tests, we selected six films: four slide films (Kodachrome 64, Ektachrome 64, Agfachrome 64, and Fujichrome 100) and two color-negative films (Kodacolor II and Fujicolor F-2 100). We selected these as the most representative of the fine-grain medium-speed films from which one could expect the best pictures. There are, of course, other films we could have chosen, but we were not pitting film against film but system against system.

We decided to try our films on three kinds of pictures that would typify the kinds of pictures most people take: an outdoor picture with a person in it, a scenic view, and, using electronic flash, an indoor family portrait.

All film processing was done by either the film manufacturer's own labs (Kodak) or by authorized labs (Agfa and Fuji). The prints were all made by a commercial processor. We also had a number of prints made—very expensively—by two custom labs to see what effect spreading extra money around would have. We'll get to that later.

The results are shown on the following two pages. Bear in mind that you're looking at pictures that have gone through two further processes since the prints were made: a color "assembly," in which all the prints are optically filtered and photographed to create one large piece of film of exactly the size in which they appear in the magazine; and the actual offset printing process.

Continued



KODACHROME 64

How they compared: Although the **Kodachrome 64** slides were excellent, the prints suffered from reddishness. PS Senior Editor Richard Stepler is kneeling on sand redder than that in the slide; and, at bottom, the picture of Senior Editor Bill Hawkins' family lacks contrast. **Ektachrome 64** slides have also been reddened in

EKTACHROME 64

transition to prints. Seaport print lacks sharpness. Hawkins picture is cold and lacks contrast—but is close to slide. **Agfachrome 64** prints are all warmer (redder) than original slides, which were already somewhat reddish, and show some graininess (as did slides). Skin tones and sharpness are both good. **Fujichrome 100**

AGFACHROME 64

A number of interesting phenomena appeared during the course of our project. Cropping, for example. In taking the pictures, photographer John Keating had set his camera on a tripod and had shot the identical scene with each film. Although our print size—3½-by-five inches—was very close in proportions to the 24-by-36 mm of the original film frame, all the prints were cropped to some degree. The dockside scenes show the greatest extremes; in the Agfachrome and Fujichrome photos the lifeboat is clearly inside the picture. In the other pictures it is cut almost in half. Yet all prints were made by the same lab. In the flash photos, the labs have sometimes chopped off the top of PS Senior Editor Bill Hawkins' head, and other times cut off the little Hawkinses' feet. Why?

A Kodak spokesman gave us part of

the answer: The system is set up for the production of prints taken by cameras with different optical characteristics. But all cameras have one property in common: Their pictures are sharper in the center than on the edges. Thus, a print that cuts out the edges will be sharper than one that reproduces the whole slide or negative in the print.

Helping the amateur

Also, amateurs tend to get farther back from their subjects than pros do. By cropping out the edges, the print maker usually omits unnecessary background and comes closer to the picture the photographer really had in mind.

Also, the film in a slide is not flat. It tends to bulge out slightly from its mount; in profile, it would look a little like a pillow. By using a mask, the lab

diminishes the area of unsharpness in the print.

And finally, the viewfinders in most 35-mm cameras are designed to deceive you. They don't show the full scene the camera is actually recording on the film; typically they show 90-odd percent. One reason for that, with slide film, is that part of the scene ends up under the mount. In effect, thus, the viewfinder is showing you the *usable* part of the scene. By cropping, the print maker is probably delivering the picture you saw in your viewfinder, as you would actually prefer it.

The system, designed primarily for the amateur photographer, was destructive of our photographer's intentions. As a professional, he shoots tightly, filling the frame. The viewfinder of the camera he used for our pictures, a Nikon F, shows the full



FUJICHROME 100

KODACOLOR II

FUJICOLOR F-2 100

prints are all excessively reddish, adding to existing reddish tinge of slides. Note pinkish buildings and red water in seaport picture. Skin tones are on reddish side. **Kodacolor II** prints (from negative) have excellent skin tones (PS jury considered them the best skin tones) with very good color balance and contrast, but

varying sharpness (not all Kodacolor prints were as sharp as these). **Fujicolor F-2 100** prints exhibit unfortunate cropping and frequently unsharpness. But skin tones were very pleasant, though slightly on the warm side. The yellows were good, and the family portrait pictures were considered very pleasing.

scene recorded on the film. Because of the cropping, however, some of each scene never appeared on our prints.

We looked, also, for three other qualities in our prints.

- **Sharpness.** Unexpectedly, print sharpness turned out to be a problem. While all of our slides and negatives were beautifully sharp, the prints varied widely. Even the most expensive automatic-focusing enlargers need periodic refocusing; in some cases, obviously, the enlargers that made our prints needed attention. Here, however, expensive custom prints shone; all were critically sharp.

- **Color accuracy.** Somewhat to our surprise, the factor of slide or negative film seemed to make little difference. Each film had its own color characteristics, and these tended to come through in the prints. The two Kodak slide films were clearly cool—tending

toward blue. Fujichrome and Fujicolor were warmer, with a slight yellowish coloration. Agfachrome tended very slightly toward the magenta. In general, the prints tended to intensify the warm characteristics, giving human subjects healthily pink cheeks, and turning buildings red.

- **Graininess.** Even though the image in a color photograph is formed by dyes, the dye image is based on a grain structure formed originally by silver halide crystals. Our prints exhibited varying degrees of graininess.

And the conclusions

What were our conclusions in the negative vs. slide controversy? In general, neither type of film proved superior to the other as a base for prints. Color was quite good in both. In making the prints, the labs cropped both as mercilessly (or kindly, depending

on your viewpoint). And general quality seemed to depend more on the competence and quality standards of the lab than on the kind of film they were printing from. Although commercial prints compared very well with our expensive custom prints in color quality, in all other respects the custom prints excelled.

Our advice would be this: Select the film family you like best for color and graininess—and the ultimate need you have, whether slides or prints. Inspect your prints carefully, and don't assume, if they are poor, that it is your fault. Ask to have them remade.

And last: Between slides and prints, it is no contest. The fine grain and subtlety of color and contrast possible with a good slide are far superior to anything possible with a print. If you really like color pictures, it's hard to beat a good slide.

Optical vs mechanical: the coming battle of the video-disc players

Several incompatible disc machines will tease the eager buyer next year

By JOHN FREE

If you're confused by ads citing advantages of one video-tape machine over an incompatible competitor, brace yourself. More befuddlement is brewing. Early next year, makers of two—and perhaps three—mutually incompatible video-disc players will each be

shouting the virtues of their products while cleverly knocking the others.

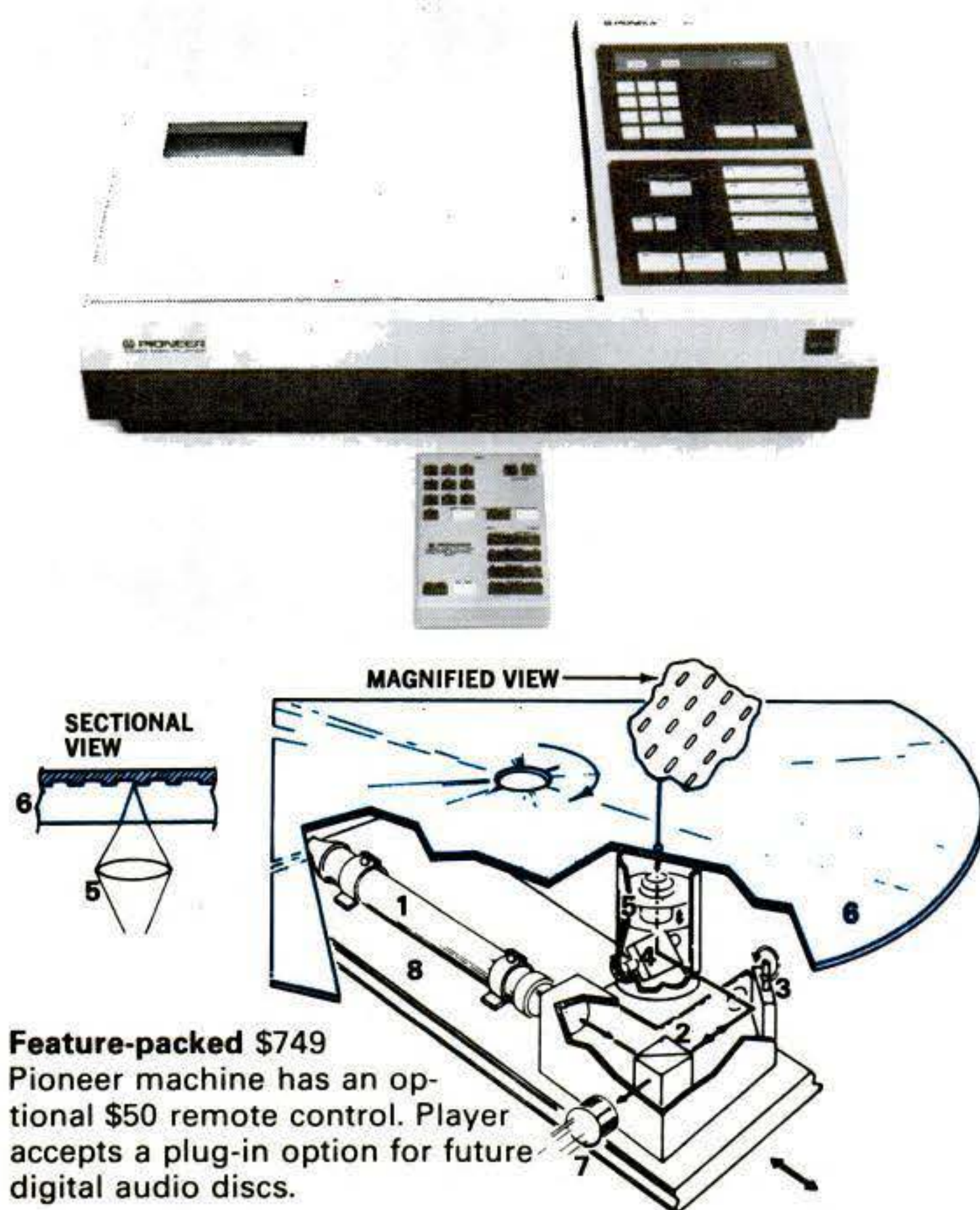
Battle lines between two differing disc technologies took shape in the early 1970's with demonstrations of early lab prototypes. Despite attempts at standardization, the lines hardened for two types of disc players: Optical, involving touchless disc playback with a laser beam, and mechanical systems, requiring contact between the disc and pickup stylus.

Proponents of the mechanical systems point out the basic simplicity of

their approach and its low costs for mass marketing. Those favoring optical systems stress the no-wear advantages of laser-beam playback. (Lasers last over 10,000 hours.) Proponents of the optical route also say that mass production of optics and a switch to solid-state lasers will cut prices.

Pictures I've seen from the newest Pioneer, Magnavox, and RCA players are all amazingly detailed and noise-free. What follows should help delineate the differences between these players.

Optical machines: laser playback



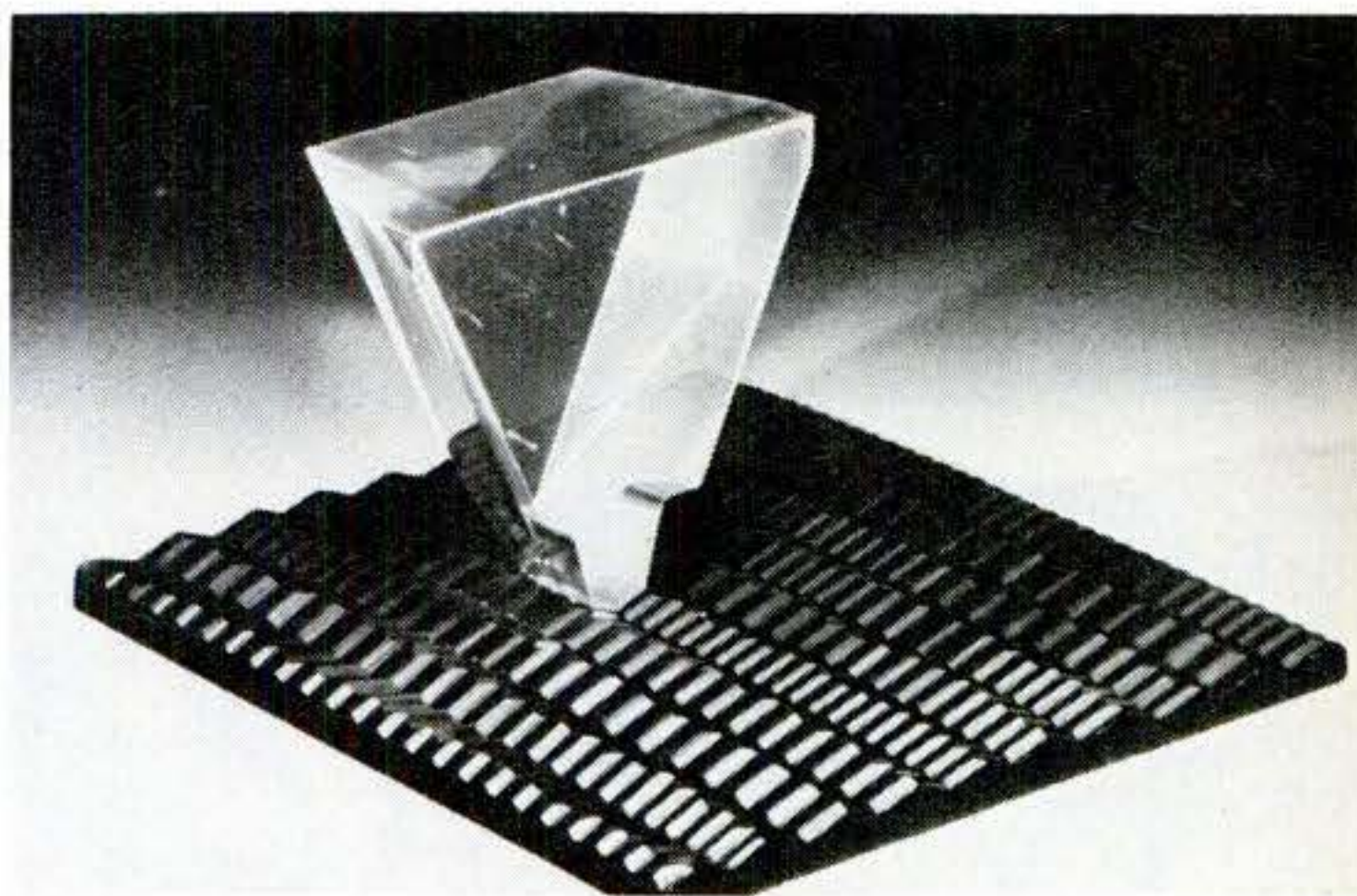
Feature-packed \$749

Pioneer machine has an optional \$50 remote control. Player accepts a plug-in option for future digital audio discs.

Two optical video-disc players, made by Japan's Universal Pioneer Corp. and by Magnavox here, are being test-marketed in a limited number of cities. Magnavox plans nationwide sales this year, Pioneer next year. The machines play compatible 12-inch discs by bouncing a focused laser beam from a spiral track of microscopic pits etched on the disc's reflective surface. A clear plastic coating makes the disc immune to dust and smudges from handling. Two types of discs are sold: Those with a half hour per side of programming play at 1800 rpm. Player controls enable you to freeze a TV picture, quickly scan a disc, play forward and reverse slow motion, or pick a specific TV frame by displaying its number on the screen. Pioneer's VP-1000 player and remote control have a numbered key pad for direct frame-number selection; Magnavox's Magnavision requires scanning to the desired frame. Hour-per-side discs have more than one TV frame on each circular track, so freeze-frame and related features will not work. (Playback rpm gradually changes from inner to outer tracks.) Both players have output jacks for optional stereo hi-fi (or dual-language tracks). Pioneer Artists Inc. and other new software firms will provide a stream of stereo/video music performances. Also, movie makers plan to release films to theaters and for discs almost simultaneously. Discs cost from \$6 to \$25. Both players, with minor variations, have laser-based optics (left) to play discs standardized by Philips and MCA. A beam from a laser (1) is deflected by a prism (2) and mirrors (3, 4) through a lens (5) onto the disc (6). Metal between pits flashes light back to a photodetector (7) for conversion to an electronic TV signal. The entire mechanism moves radially on a slide (8) linked to the electronic servo circuits that control its movement.

RCA: grooved capacitance disc

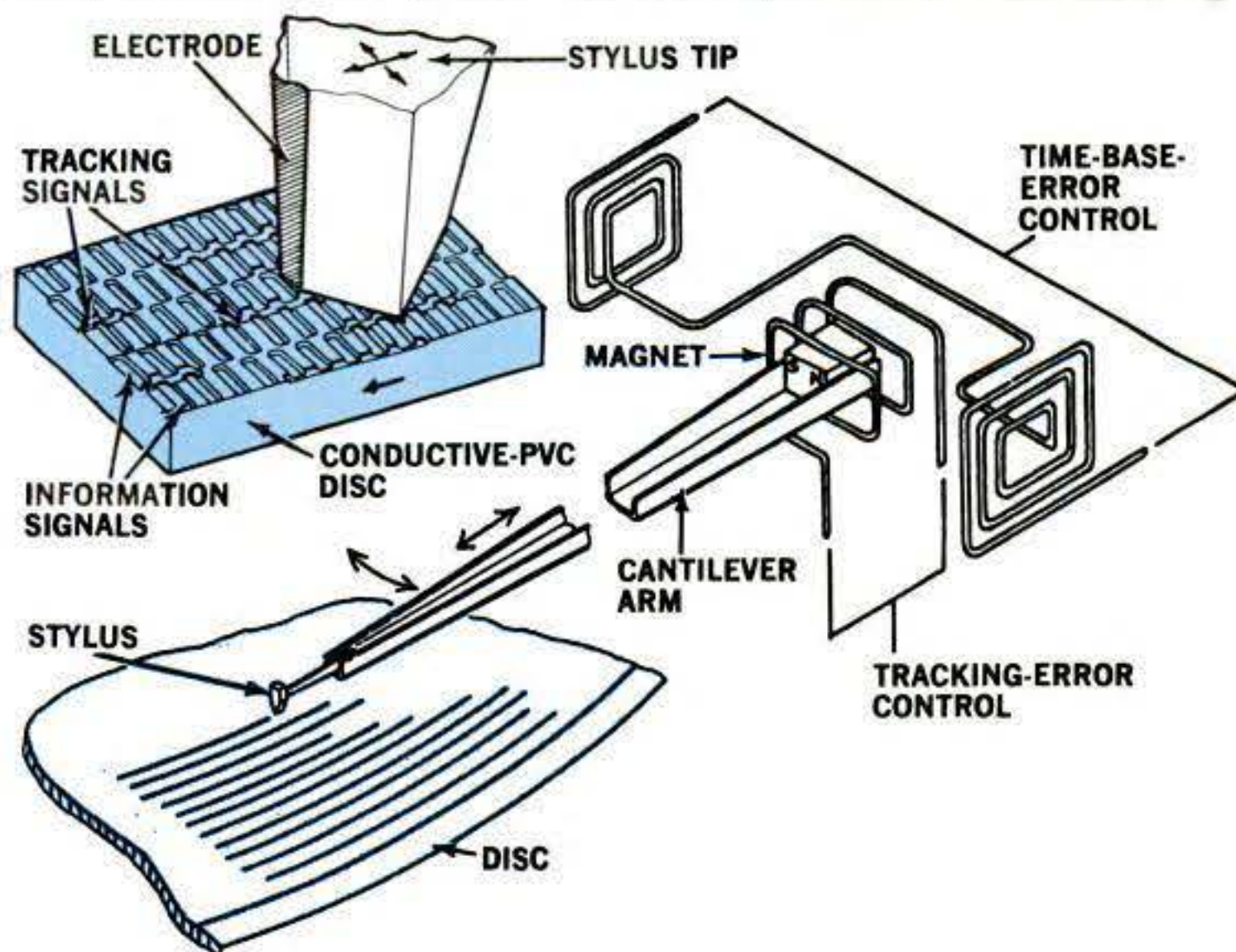
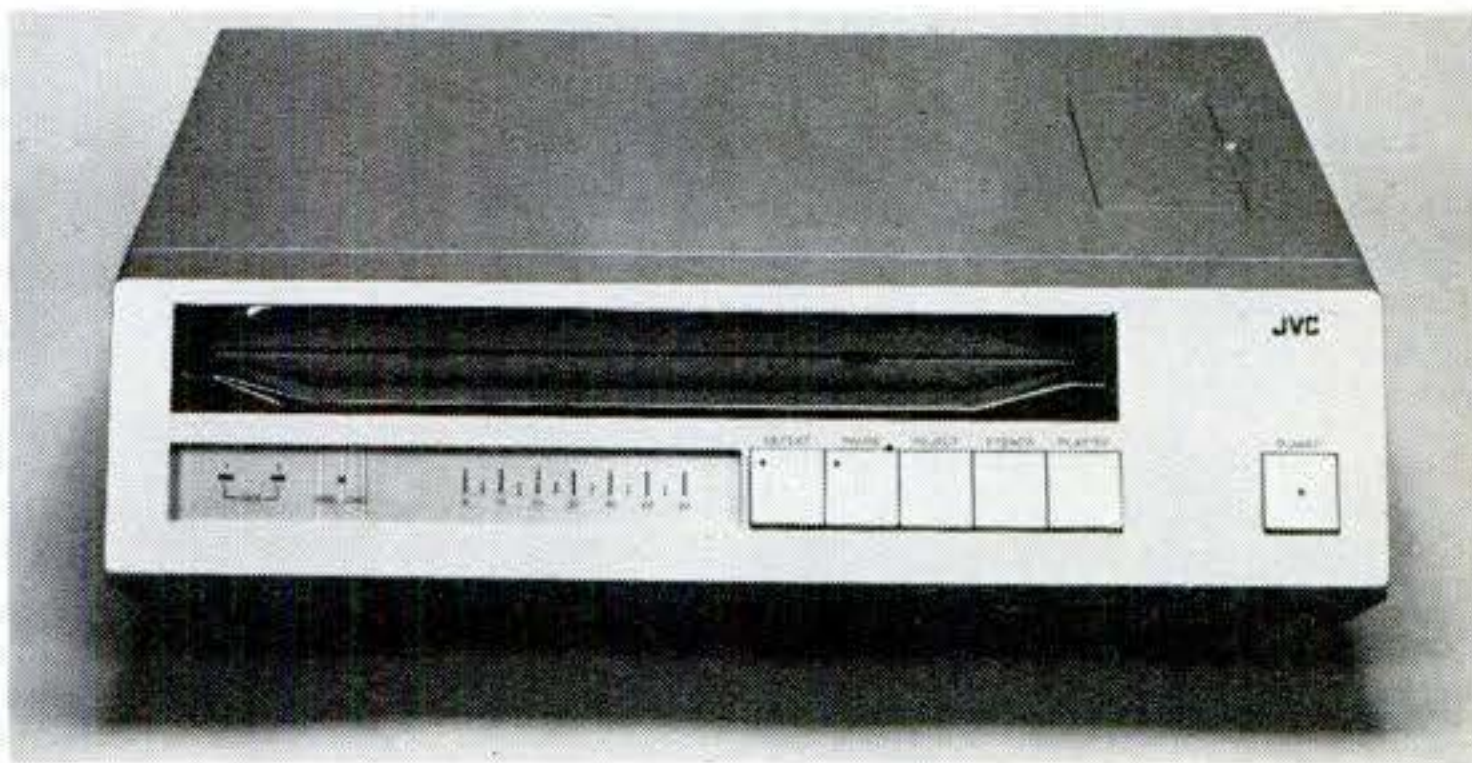
RCA's SelectaVision video-disc player has been completely overhauled since it was introduced and field-tested several years ago [PS, Feb. '77]. The basic playback principle is unchanged: A stylus electrode, replaced every two or three years, senses the TV signal as electrical capacitance variations in disc grooves spinning at 450 rpm. Playing time was boosted to one hour per 12-inch disc side by doubling disc grooves to just under 10,000 per inch. Home tests showed that dust and other groove contaminants from handling messed up pictures. So RCA's improved SelectaVision has sealed disc "caddies." Slip the caddy into a player slot (photo) and the disc is loaded automatically. This contact-free, sealed-player approach sharply reduces groove contamination. Spiral grooves, with four TV frames per revolution, do not permit freeze-frame and similar features now. These operating features may go into future step-up models using electronic memories to store images. Two fast-search buttons, though, let you jump the stylus forward or back to quickly locate a scene visually. Also, two other search buttons move the tone arm and display its position as time on digital readouts. RCA does not plan to include stereo hi-fi capability on its initial model, slated for nationwide marketing early next year. The player's simple construction, plus many microcircuits, should keep RCA's price under \$500. Discs will be \$15 to \$20, depending on content. RCA's low-cost approach has gained powerful allies: Zenith and undoubtedly other TV firms will market or make SelectaVisions. CBS Inc. will help expand disc titles from 150 to 300 in the first year. Programs from several film companies range from classics, musicals, current films, and how-to, to TV series such as *Star Trek* (10 episodes) and *Victory at Sea* (a 90-minute version), and *Heidi* and *Hans Brinker* for children.



Metal-backed diamond stylus forms electronic circuit to convert minute capacitance variations in grooves into TV pictures. Compact, microcomputer-controlled player has viewing window.

JVC: grooveless capacitance disc

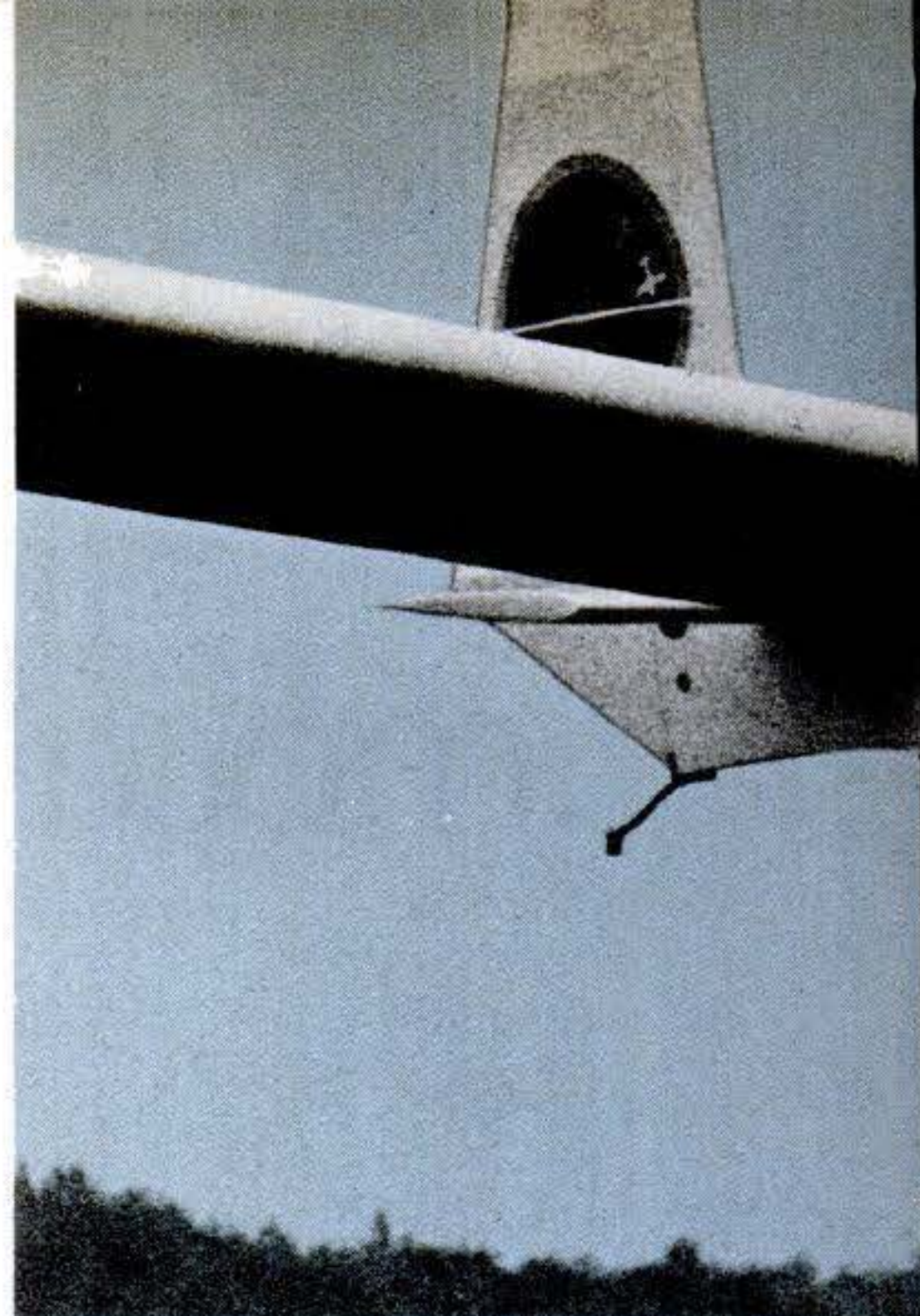
Victor Company of Japan (or JVC here) rolled out a disc system in 1978 that combines the low-cost aspects of SelectaVision (above) with the operating options—freeze-frame, slow-motion, etc.—of optical machines. Not only that, JVC included options for a super-hi-fi audio disc. It calls the whole package its VHD/AHD system (video and audio high density). Matsushita, Victor's parent firm in Japan, could offer VHD/AHD through its Panasonic and Quasar subsidiaries. An announcement about marketing is expected this summer. VHD/AHD hour-per-side discs are just over 10 inches in diameter and rotate at 900 rpm. Signals are stored as capacitance variations, produced by minute pits in the conductive plastic. The stylus rests over several spiral tracks, distributing pressure and minimizing wear. (Stylus life is 2000 hours, roughly 10 times RCA's.) But the metal stylus electrode "reads" just one information track and the tracking signals on either side of it. These tracking signals keep the stylus on the right path by feeding current to a coil/magnet combination on the arm, which can move sideways. The cantilever arm can also be stretched or shortened instantly to correct for speed variations (time-base errors). Signals sent to coils can be used to make the stylus replay one frame continuously, move ahead or back at slow speed, etc. JVC has also demonstrated an optional random-access unit with a wireless remote control for the main VHD/AHD player. It has memories and numbered key pads for preprogrammed display of selected TV frames. Another plug-in option unscrambles digitally coded audio discs that have a dynamic range over 90 dB and other super-fidelity specifications. At this writing, JVC has not revealed video software sources needed to sell its system successfully. Europe's Thorn-EMI Ltd., though, has agreed to produce both players and software. PS



Prototype player has slot for loading discs from JVC's sealed caddies. The stylus, which can be electromechanically maneuvered, wears down along its entire length for long life.

Sun-powered planes

test-fly on two continents



Newest aircraft fuel: not moonshine. Sunshine

By BEN KOCIVAR

The first flight was really just a hop—the plane covered as much ground as a quarterback does making two first downs. The record flight distance is just over a kilometer at a top speed of 78 km/h. Hardly impressive stats. Yet these faltering flights of the first man-carrying solar-powered aircraft may be as significant as the Wright brothers' first trials.

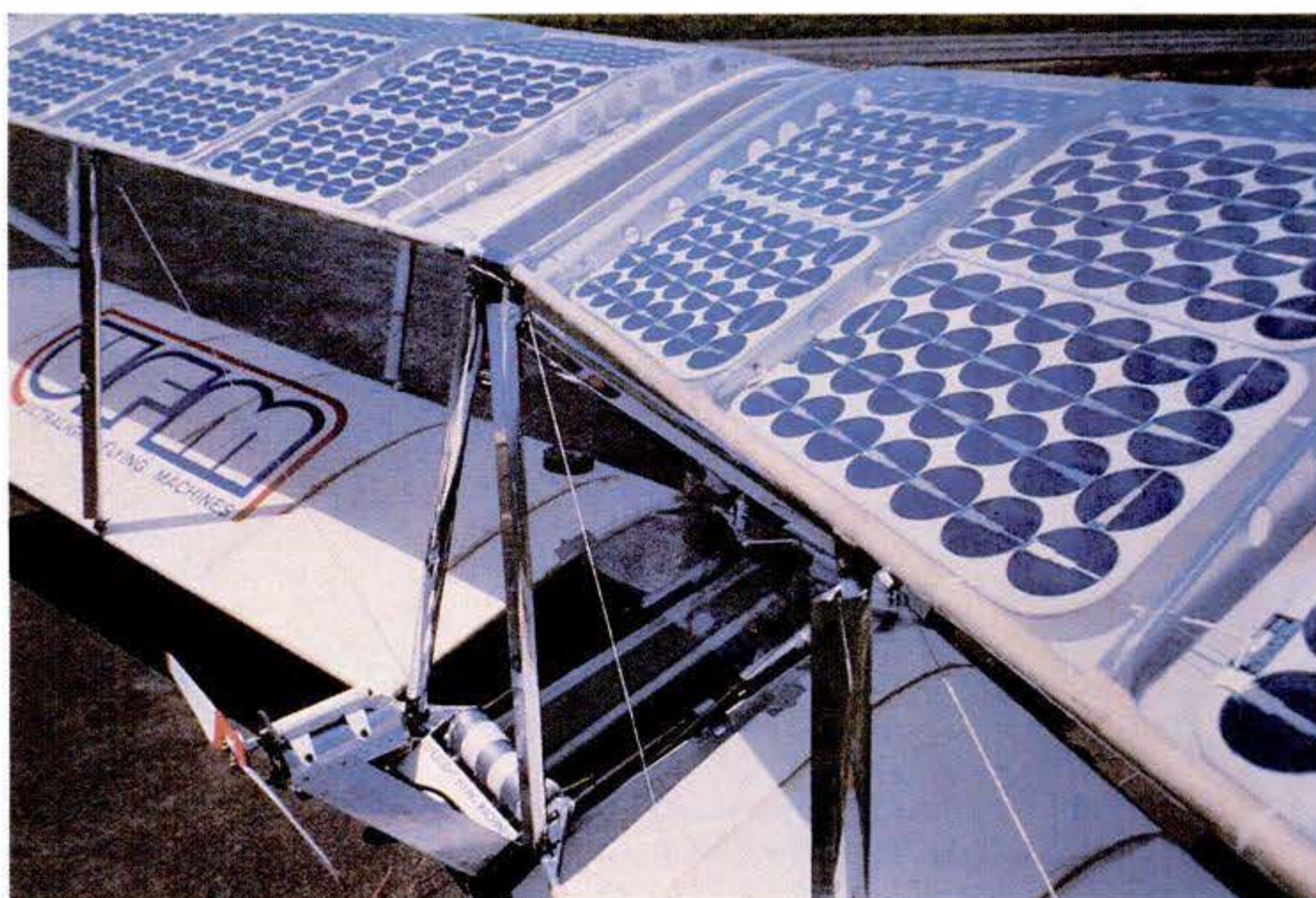
The two solar-powered planes shown here were developed by a British and an American entrepreneur working independently of each other. Though their designs differ, both planes are basically proof-of-concept prototypes. Before taking wing for a brief flight, each must sit in the sun for a couple of hours, charging up batteries. But the inventors' goal is sustained solar-powered flight. And each thinks the goal is attainable if more efficient, lighter, and cheaper components can be developed.

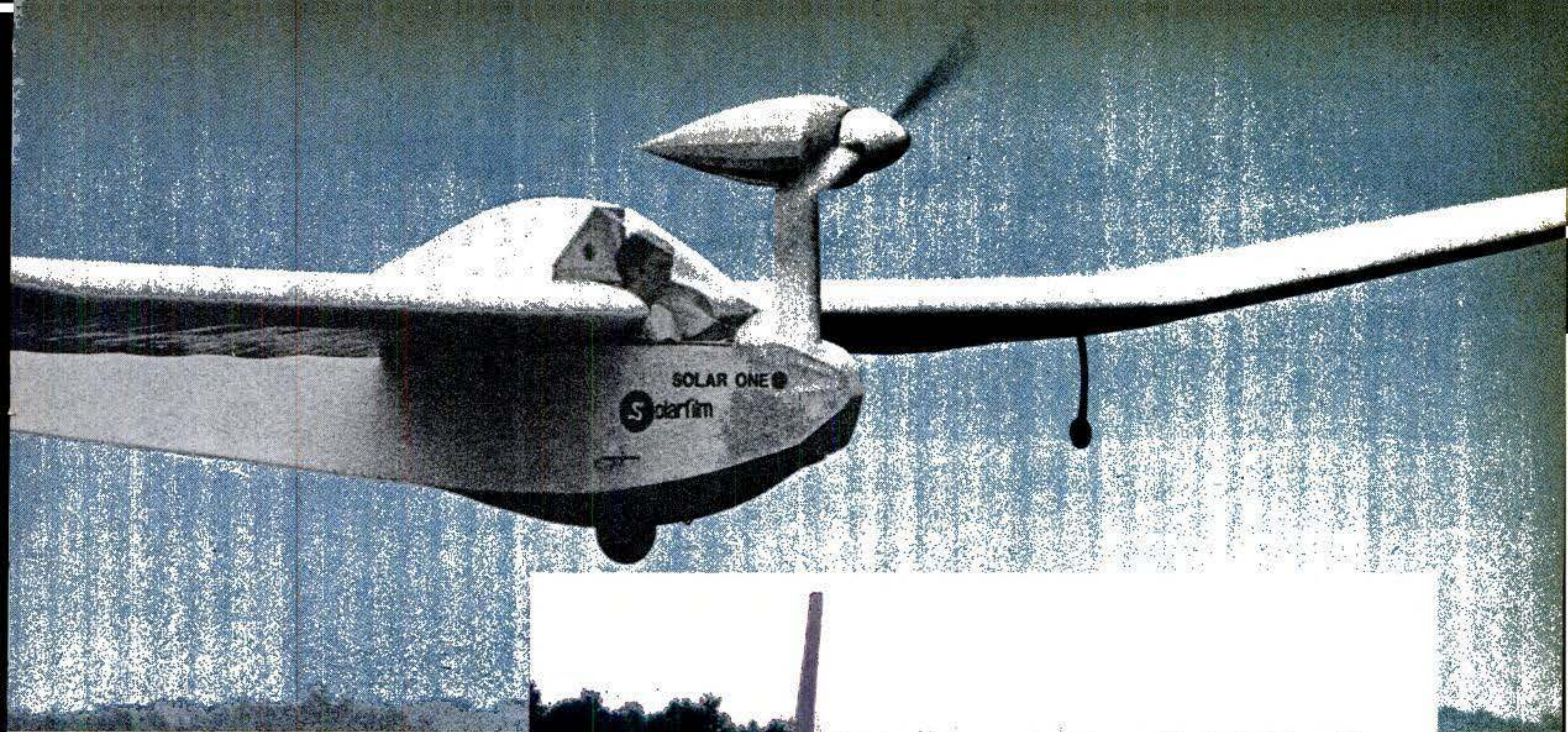
Each ultralight plane has essentially the same propulsion system: small electric motors, powered by onboard batteries that are charged by wing-mounted solar photovoltaic cells.

"We need cheaper solar cells," says Britain's Fred To, who spent \$35,000 to build Solar One. On Dec. 19, 1978, his plane made the first solar-powered flight, a short, 18-m dash over Lasham airfield outside London.

The plane's 21-m wingspan was de-

Solar biplane (above left) takes off. Its one-meter pusher prop is spun by a three-hp electric motor. Solar cells on wings (left) produce 350 watts at 30 V.





signed for about 20 sq. meters of solar cells, but the British team could afford to install only 3½ sq. meters—750 cells in all. This array takes up to two hours to fully charge the craft's 25 amp-hr. nicad power pack. The charged batteries store enough energy for about eight minutes of climbing and a few minutes of cruising.

At press time, the 104-kg craft's longest recorded flight, made on June 13, 1979, was 1.1 km at a maximum altitude of 24 m.

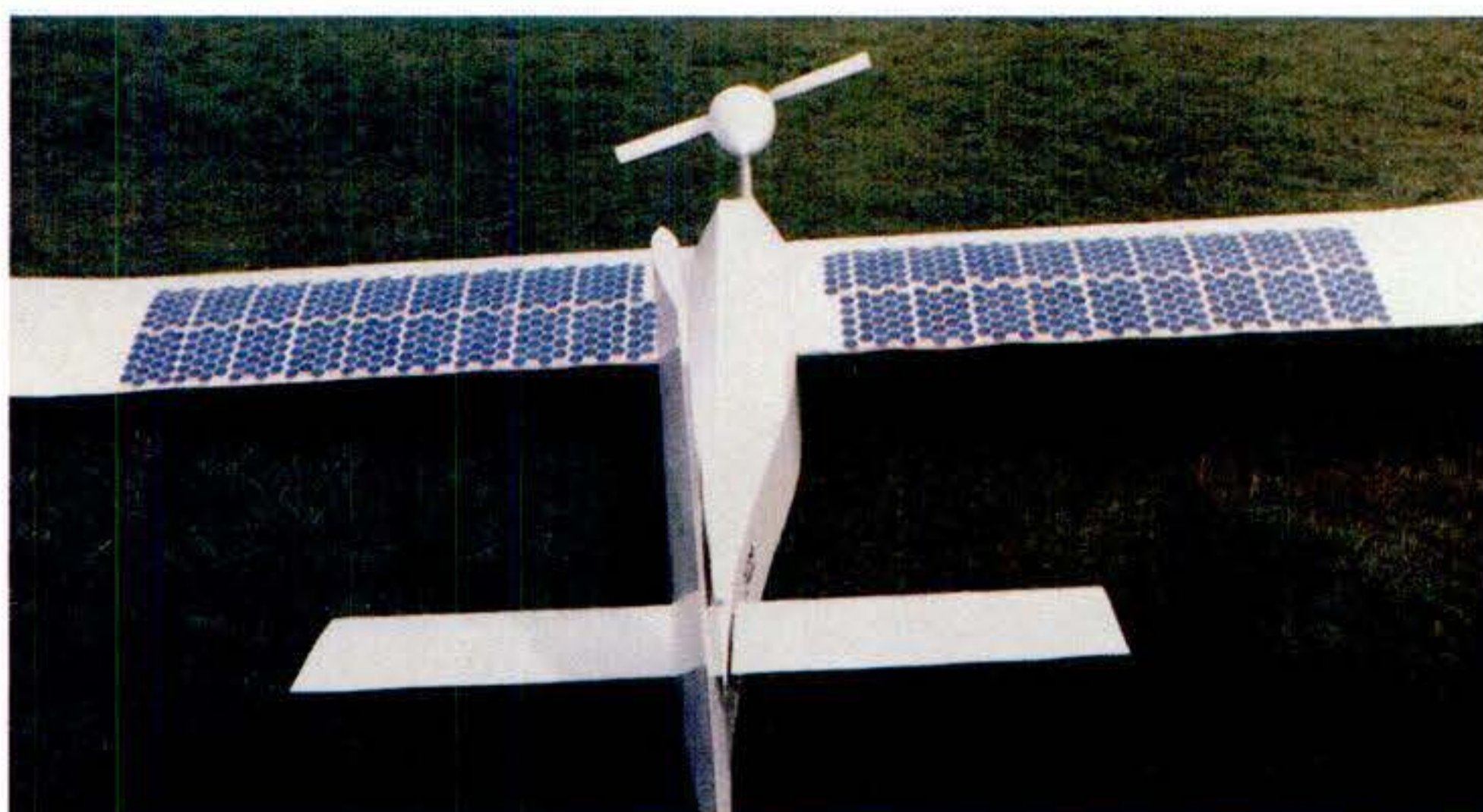
"With the full complement of solar cells, Solar One could have cruised continuously under sunshine," says developer To.

More test flights are planned, while To and his group raise funds for the next phase. "With the possibility of a full complement of cells, we hope that Solar One will be able to make a Paris-to-London flight," says To. "This would stretch the craft's performance to almost its design limits," he adds.

Californian Larry Mauro also says that more solar cells would improve the efficiency of his 57-kg craft. Solar Riser is a hang glider fitted with 500 solar cells, a small electric motor, and a Hughes 500 helicopter battery. The craft's first flight, on April 29, 1979, covered 0.8 km at altitudes of 12 m.

Solar Riser's nine-meter wingspan could hold twice as many solar cells, says Mauro. The present array takes about an hour to charge the battery for a three-to-five-minute flight. With a larger array and a lighter, more efficient battery, the craft could cruise continuously under power, charging as it flies.

These projected improvements may remain theory. At press time Mauro had no further plans for Solar Riser—the craft was on display in the Museum of the Experimental Aircraft



Soaring on sunshine (top), the British-made Solar One gets power from an array of circular solar cells (above). Fred To, the craft's developer (center), displays the plane's propulsion system (shown minus

motor cowling). Four off-the-shelf Bosch permanent-magnet motors, linked by chain drive, produce about four hp. A 3:1 reduction gear spins the prop at about 1100 rpm, less as the nicads run down.

Assn. at Haines Corners, Wis. But he continues to market the Easy Riser kit for the basic glider. (For more information, write to Mauro at 2960 Corvin Dr., Santa Clara, Calif. 95051.)

By contrast, the British team has ambitious designs. Developer To has asked a British motor manufacturer

to design a lighter, more efficient DC motor for the plane. And the team is studying plans for a two-seater production version. It would cruise at around 110 km/h and have a 480-km range. "With the expected drop in the price of solar cells," says To, "such an aircraft might become a reality in five years."

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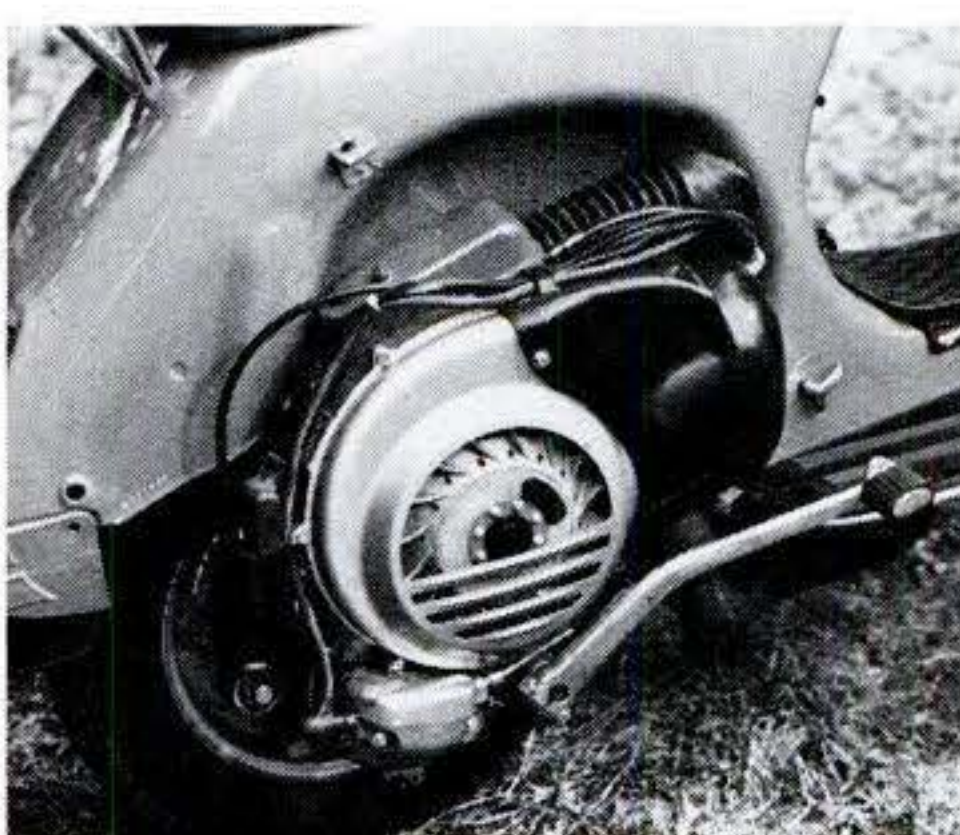


Motorized two-wheelers

economical
all-weather
transportation



Honda Express is an ideal short-distance commuter. It's light (about 120 lbs. with a tank of gas and oil), and very easy to ride. Unlike a moped, it has no pedals. A unique system allows easy starting. You simply press down the start lever with your foot two or three times to "wind the starter up." Then you pull a lever and the engine starts. The 49-cc two-stroke engine will propel the Express at a maximum speed of about 30 mph. The clutch is automatic, and there are no gears to shift. It has turn signals, lights, horn, and is licensable for the street (if licenses are required). Gas mileage is over 100 mpg. Ideal for short trips, the Honda Express NA 50 costs \$455. A less expensive version is also available.



Vespa P200E motor scooter is powered by a 198-cc two-stroke Vespa engine. The scooter alone costs \$1539. Windshield and mirrors are \$136. Luggage rack and backrest are an additional \$112. The scooter is capable of exceeding 55 mph on a level road. When going up hills or traveling into a head wind, it may not be able to reach 55. Floorboards offer extra protection against water splash when roads are wet. Locking storage compartment up front is fairly roomy. Spare tire—unique for a two-wheeler—is under left rear fender. Removing right rear fender cover allows access to the engine. Engine is sprung weight—it moves up and down with the rear wheel. The Vespa is easy to ride. But small wheels and quick steering make it less stable than a motorcycle. Gas mileage on our test scooter was certainly not exceptional. A 56-mile ride by the author used 1.6 gallons, for an average of 35 mpg. The trip was a combination of 55-mph expressway driving and in-town stop-and-go. The engine had only 30 miles on it when we got it. A broken-in unit would probably have gotten better mileage.

By RAY HILL

A light rain is falling as you ride your motorcycle away from home. Thirty miles later you ride into the garage beside your office building. A line of cars is waiting to get in. But your bike is small, so you ride past the cars to the parking area reserved for motorcycles and mopeds.

Not having to wait and knowing that the parking fee is less for your motorcycle brings a smile to your face as you take the elevator up to your

office. You put your rain gear in the closet, and begin the day's work.

If you aren't commuting economically and conveniently, you could be. Contrary to popular belief, motorcycles aren't merely warm-weather, recreational vehicles. They can be ridden to work or to shopping centers safely, and in reasonable comfort, even in cold and rain. The same goes for the motorcycle's smaller, slower, and less expensive cousins—mopeds, motor scooters, and small-engined two-wheelers without pedals.

Oh, you say, they may be economi-

cal, but they're too dangerous. I don't know how to ride one. Besides, I have to wear a suit to the office; it would get wrinkled and dirty.

Not so. As the accompanying photographs show, modern clothing and equipment allow you to keep your clothes dry, clean, and unwrinkled—in any weather.

It's true that motorcycles are inherently more dangerous than cars, because you lack the protection of the car's metal body and you have only two wheels under you instead of four. But training, practice, and sensible riding can assure safe operation. I know of people in their 70's who ride daily without mishap.

How cheap is it to run powered two-wheelers? Even the largest-displacement motorcycles are capable of 55

Continued

Powered two-wheelers (left to right) are: Yamaha XS 11, Vespa P200E, Honda PA 50, and Honda Express NA 50. XS 11 is piloted by PS staffer Ray Hill, an experienced motorcyclist. Other three machines, however, are being ridden by,

from left to right, PS staffers Dave Houser and Elaine Smay, and former PS staffer Laura Wessner. None of the three had any former motorcycle or moped experience. All three quickly adapted to starting and riding their new two-wheel vehicles.



Yamaha XS 11 can be used for going to work or traveling across the nation. XS 11 without accessories costs \$3700, weighs about 600 lbs. with a tank of gas, and can get 55 mpg at 55 mph. Motorcycle has a drive shaft instead of a chain, as do several road machines now. The drive shaft eliminates the oiling and adjusting necessary on chain-drive motorcycles. Like many street bikes today, engine has electronic ignition, which eliminates points adjustment and maintenance. Accessories on the XS shown here include a fairing (keeps wind off the upper body), lowers (to keep wind off the legs), saddlebags, luggage rack, and an adjustable backrest for a passenger. Fairing and lowers are necessary for cold-weather riding; they're also very useful in the rain. Wind and rain are deflected past the rider instead of hitting him directly in the body, which happens without a fairing. Prices for accessories vary. For the XS 11, the fairing, lowers, and mounting hardware costs about \$470. Rear luggage carrier with adjustable backrest is about \$65. And saddlebags with stylish, chrome-plated protective bars and mounting hardware cost about \$300.



Honda PA 50 moped gets over 70 mpg. Its 49-cc two-stroke engine drives the machine to a maximum speed of about 30 mph (the maximum speed achievable by most mopeds). Weight is about 115 lbs. with a tank of gas. As with other mopeds, front and rear brakes are controlled by handlebar levers. It costs \$545.

Metal baskets on the Honda Express allow you to go grocery shopping on a machine that gets over 100 mpg. These baskets are sold by Honda for \$10.95, but many other aftermarket makers sell baskets for most mopeds. Baskets are also available that fit on the front of powered two-wheelers.



Saddlebags are available for larger motorcycles. These handsome Vetter bags are quickly detachable with a key, and can be carried as suitcases. Most bags aren't big enough to contain a helmet—these are. Bags and mounting hardware are about \$315. You can install them yourself with basic hand tools.



Vetter Hippo Hands are like giant gloves. A Hippo Hand fits over each handgrip and is attached to the handlebars. The rider's gloved hands slip inside Hippo Hands to

operate controls. They help protect against freezing cold and rain. About \$42 at motorcycle shops. For really cold weather, wear mittens inside the Hippos.

mpg. Many of the smaller ones get over 70 mpg. And some mopeds and other small-engined two-wheelers get even better mileage. With today's rising gas prices and shrinking dollars, a motorized two-wheeler might make economic sense for you.

What's available

Which machine is for you? There are five major motorcycle makers—Honda, Yamaha, Suzuki, Kawasaki, and Harley-Davidson.

Harley makes only large-displacement motorcycles. Although they can get good fuel economy, they are too large for inexperienced riders.

The remaining four manufactur-

ers—all Japanese—make a complete line of street bikes, from small to large. Honda's smallest street bike is 124 cc. Small Suzuki, Yamaha, and Kawasaki street bikes start at about 250 cc.

A 250-cc motorcycle should maintain 55 mph in all conditions. Smaller machines might not be able to go up a hill or into a headwind at 55. If you must ride on expressways, bear this in mind.

Mopeds—with manufacturers too numerous to mention—cannot exceed 30 mph. Some cannot reach 30 mph. And they go still slower up hills. While economical, they are strictly for nonexpressway, short-distance commuting. The same goes for the 49-cc machines like the Honda Express, Suzuki FS 50, and Yamaha Champ, which have moped engines but smaller-diameter wheels than mopeds and no pedals.

Motor scooters, such as the Vespa P200E, sort of fill the gap between mopeds and motorcycles. But because mileage isn't exceptional, initial purchase price is more than an equivalent

engine-size motorcycle, and handling and stability aren't equal to that of a motorcycle, a motorcycle may be a more sensible buy. Honda's CB125 motorcycle, for example, is about \$930. A KZ250 Kawasaki, 50 cc larger than the P200E scooter, is about \$1250. The P200E is \$1539. For mopeds and other 49-cc two-wheelers, figure on paying \$450 and up.

In general, after having ridden several mopeds, the Vespa P200E, and many motorcycles of all sizes, my own recommendations are these:

For distances of up to five miles, where highway speeds aren't necessary, a moped works fine. For distances up to 15 miles, a motor scooter is okay if you decide that's a better purchase than a motorcycle. For greater distances than this, or where highway speeds must be maintained, comfort and safety require a motorcycle of at least 250-cc displacement.

For cold- or wet-weather riding, where distances of more than 10–15 miles must be covered, you need a motorcycle large enough to accommodate a fairing. Windshields and small fair-

ings are available for smaller motorcycles, but you'll get better protection with a full-size fairing and lowers, such as the Vetter Windjammer (similar to the fairing and lowers shown on the XS 11 in this article). To accommodate a full-size fairing, you really need a motorcycle with an engine of 650 cc or more. Many motorcycles of 650 cc, and even bikes with larger displacement, are capable of getting 55 mpg with the fairing in place.

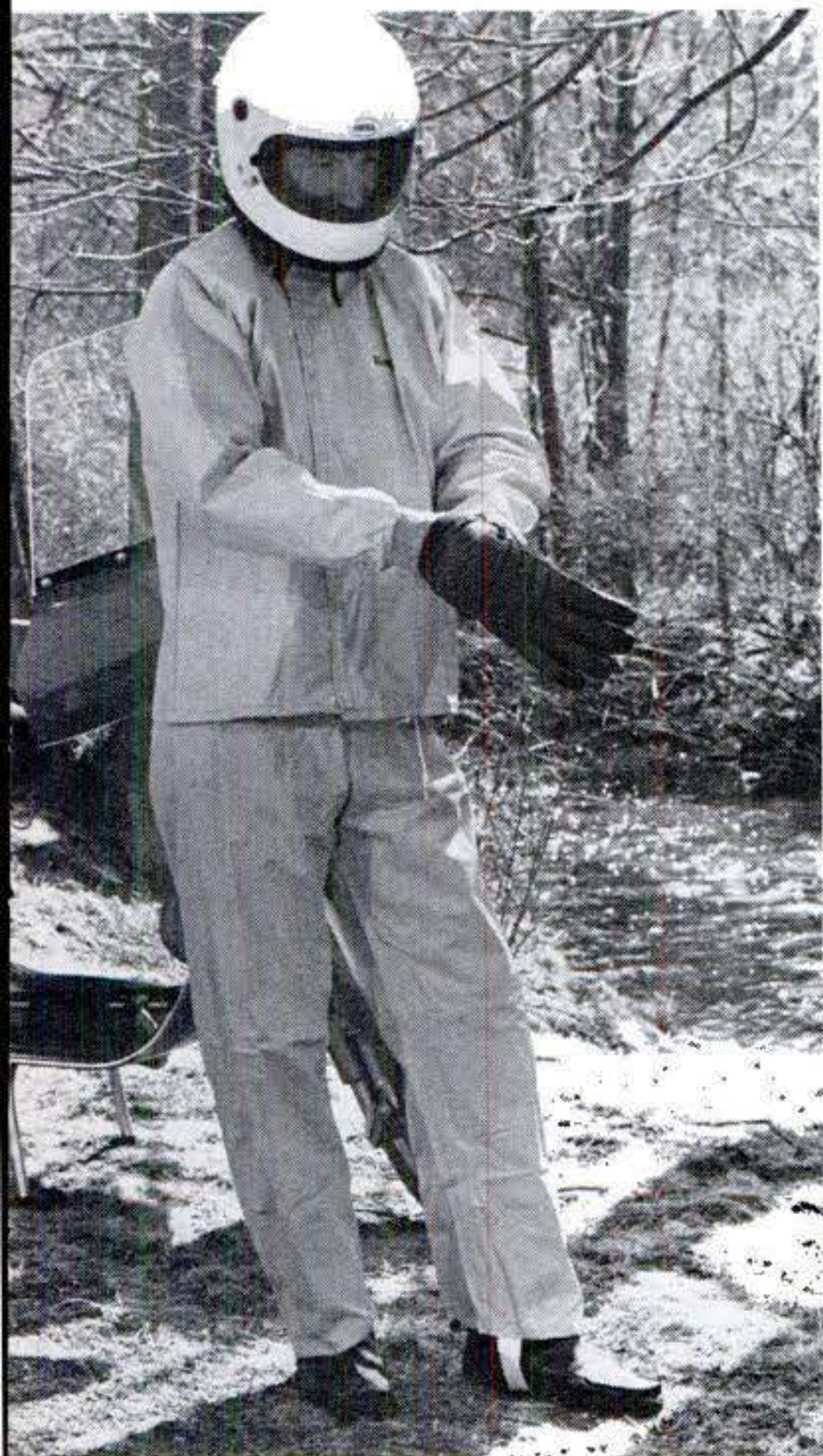
If you're handy, you may be able to make an acceptable fairing out of Plexiglas for smaller machines. I have seen some that seemed very effective, albeit a little lacking on the aesthetic side.

Insuring it

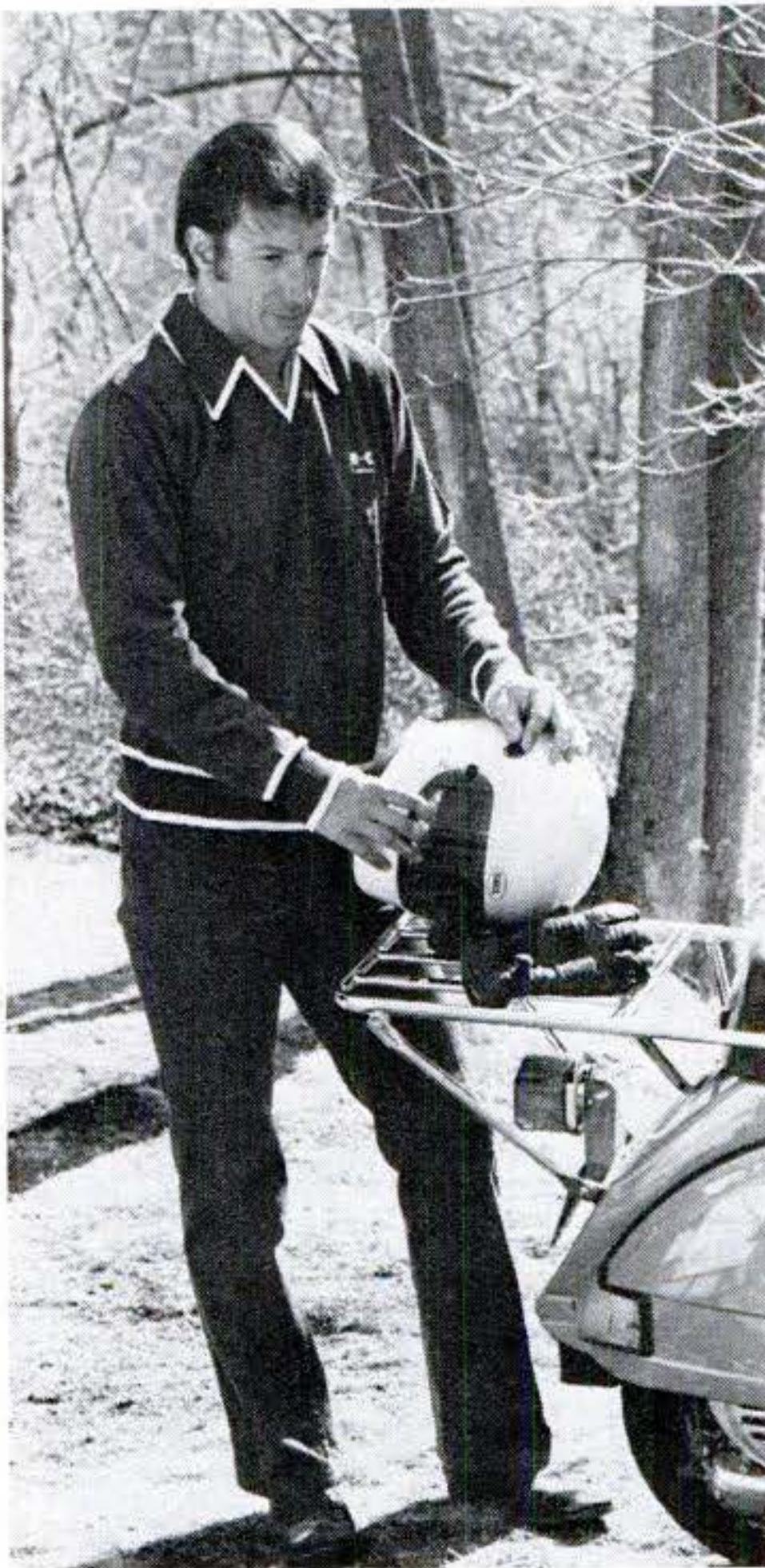
Before you buy a motorized two-wheeler, check out your area's licensing and insurance requirements. Be sure you conform to the law.

Insurance can be much cheaper for two-wheelers than for cars. For example, I pay \$37 a year for liability insurance for my 400-cc motorcycle. Often,

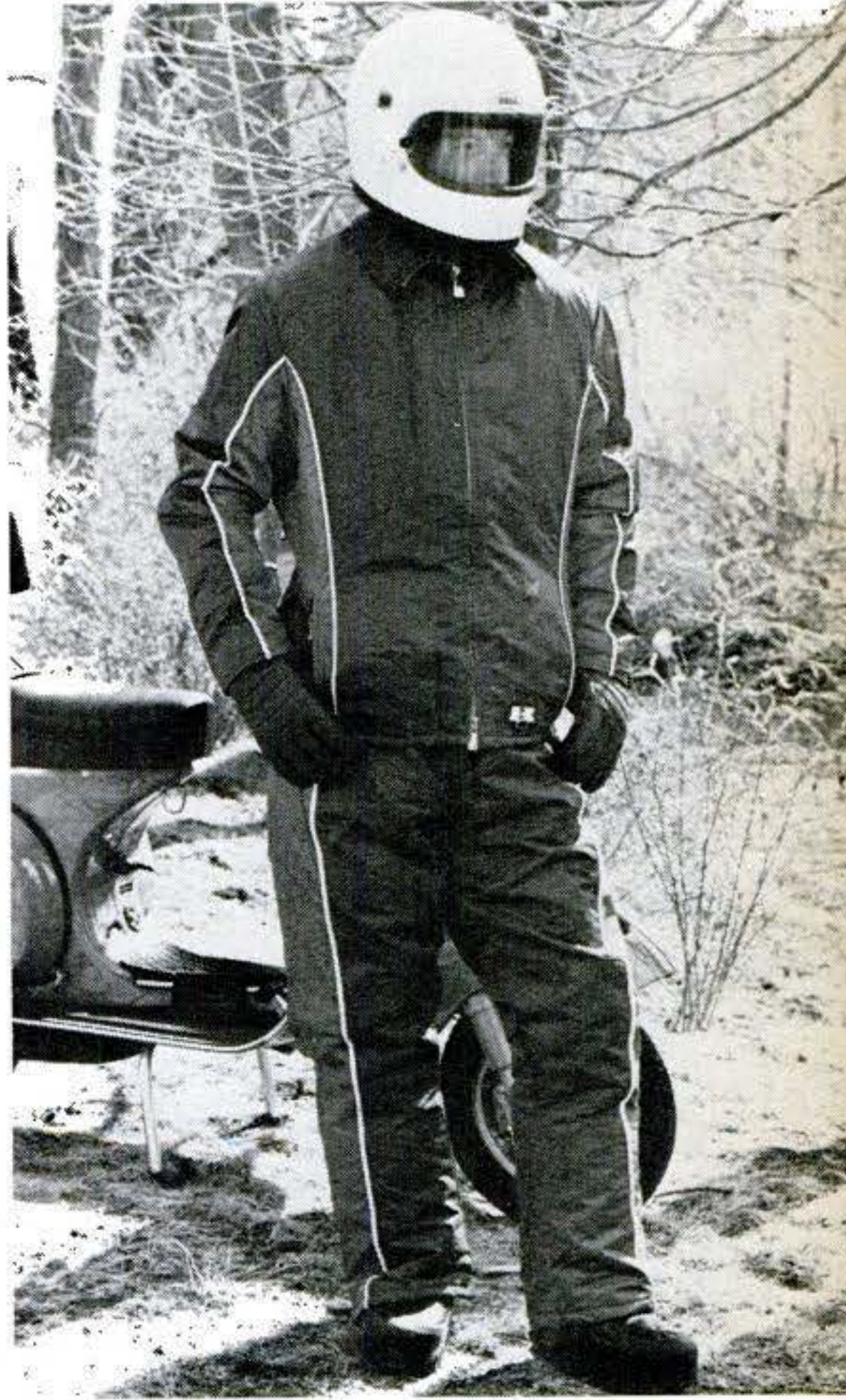
[Continued on page 110]



Rain suit, rubber boots, gloves, and a helmet are musts. A wraparound helmet for wet-weather riding is best. It offers more facial protection in the event of a spill, and also keeps cold air and rain away from the face better than an open-face helmet. Garments shown are: Bell Star II helmet, \$110; Dry Rider two-piece rain suit, \$25; Totes boots, \$12; Kawasaki gloves, \$19. Rain suit is also useful as windbreaker.



A sweater may be all you need to keep warm in moderate weather. This V-neck Kawasaki sweater costs \$15. Pants, boots, helmet, and gloves round out riding attire. As this photo illustrates, riding clothing has become very stylish and attractive. Most motorcycle shops have a complete line of apparel to choose from. Many of the garments can be worn for other kinds of outdoor activities.



Snowmobile suit is ideal for cold-weather riding. This Kawasaki suit is lined with 6.6 ounces of polyester fill. Jacket is \$73; pants are \$70. Kawasaki snowmobile boots are \$35. One-piece boot shells are waterproof. A soft, one-piece, removable urethane-foam lining comes in three sizes—small, medium, and large. The lining compresses to offer a soft but snug fit to comfortably warm all sizes of feet.

Over-and-under monorail

— a single beam for two-way taxis

By DAVID SCOTT

MUNICH, WEST GERMANY

Starting next year, the people of Hamburg will be able to peer down on the city from a Cabintaxi, a personalized urban conveyor with a difference. It has small electric cars moving in both directions, but on a single elevated track. Cars run both above and below the slim, lofty beam. This unique mass-transit system was designed here by Messerschmidt-Bölkow-

Blohm, Germany's leader in aerospace and a high-technology innovator in other fields.

There's already a demonstration setup working in Hagen, in the Ruhr area, and by mid-1981 the Hamburg line will be installed by Mannesmann Demag, MBB's construction partner in the project. This will be a one-mile loop with three overhead stations linking a commuter rail station with a nearby business district. Nine 12-passenger driverless cabs will circulate

and stop on demand. All movement will be computer-controlled. The initial installation is intended to test public acceptance and to prove feasibility.

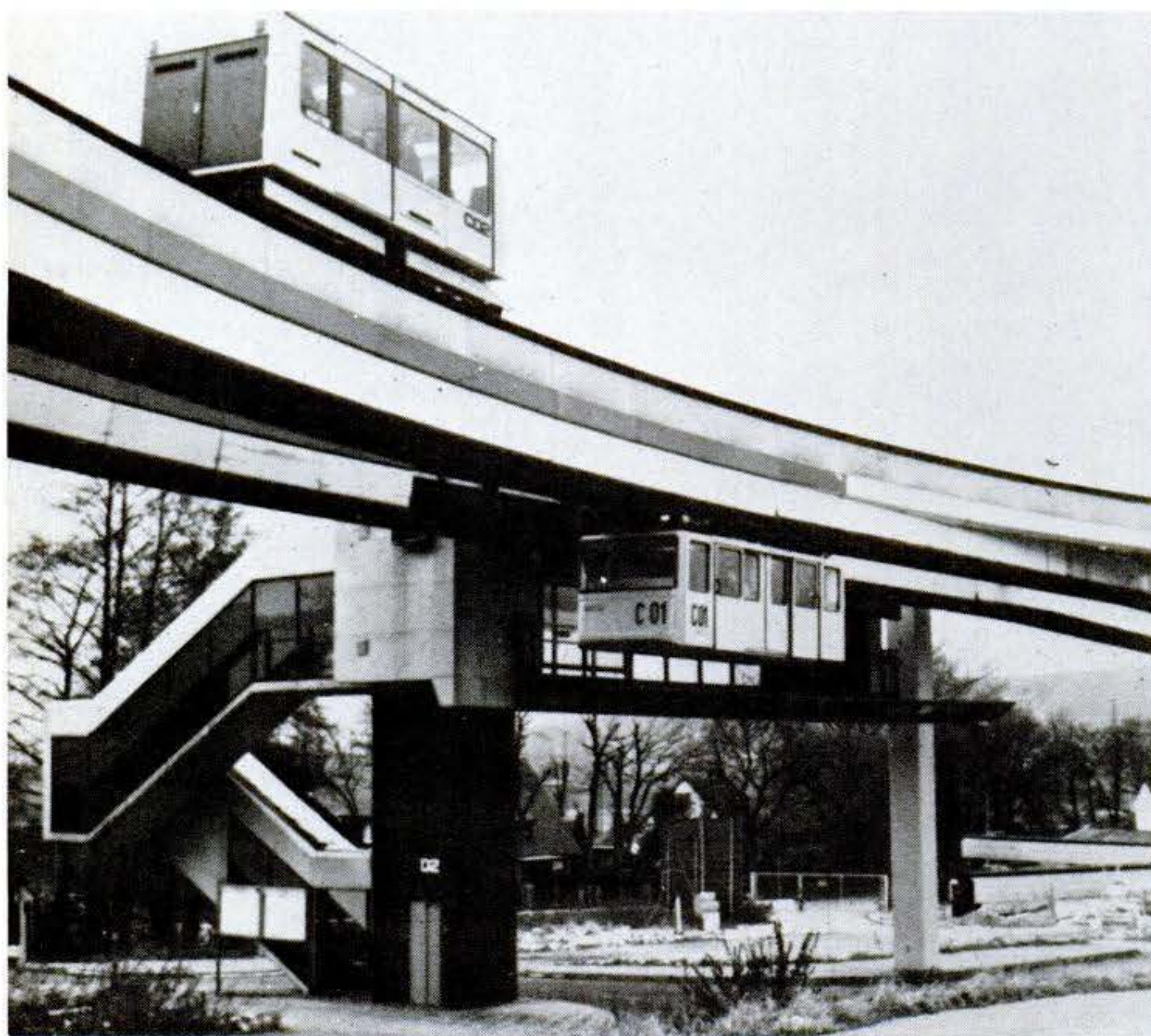
Now, let's take a ride. From the main rail station I take an escalator to the Cabintaxi level, drop a coin into a ticket-vending machine, and punch out my destination by number on a keyboard. A magnetically encoded ticket and my change drop out, and my departure platform appears on an indicator panel.

At the platform I drop the ticket into a reader that flashes my demand to the central computer. This assigns the next free car to my destination, which is displayed on the car's side for identification. I step in and press a button to close the door. That starts the journey. If one or two other people are going to the same place, we share the cab.

The computer now takes over completely. It regulates our speed, senses the position of any car ahead to maintain a safe headway, and holds us at intermediate stations only if the track is temporarily occupied. We're programmed for travel to the selected destination by the most direct path. Upon arrival, the car is released for immediate use by other travelers.

"Our over-and-under guideway is a big space-saver and cost-cutter," MBB's Gert von Lieres told me. "A two-level guideway can fit into narrow streets that couldn't accommodate parallel rails, and there's less clutter in the streets from support columns. Construction is simplified and thus relatively cheap."

It's also a quiet system; the cars glide at about 22 mph on rubber-tired wheels. And it shouldn't be affected by weather; the base, suspension, and



Single elevated station at Hagen demonstration track serves Cabintaxis on both levels for travel in either direction. Lower platform has sliding doors that open only

when a car is waiting, and an extension under the car for safety. Diverging tracks at this junction have no points; all switching is done on the cars themselves.



Twelve-passenger cars are of similar modular construction, but have different

lengths and layouts. Modules can be built to carry from three to 12 passengers.

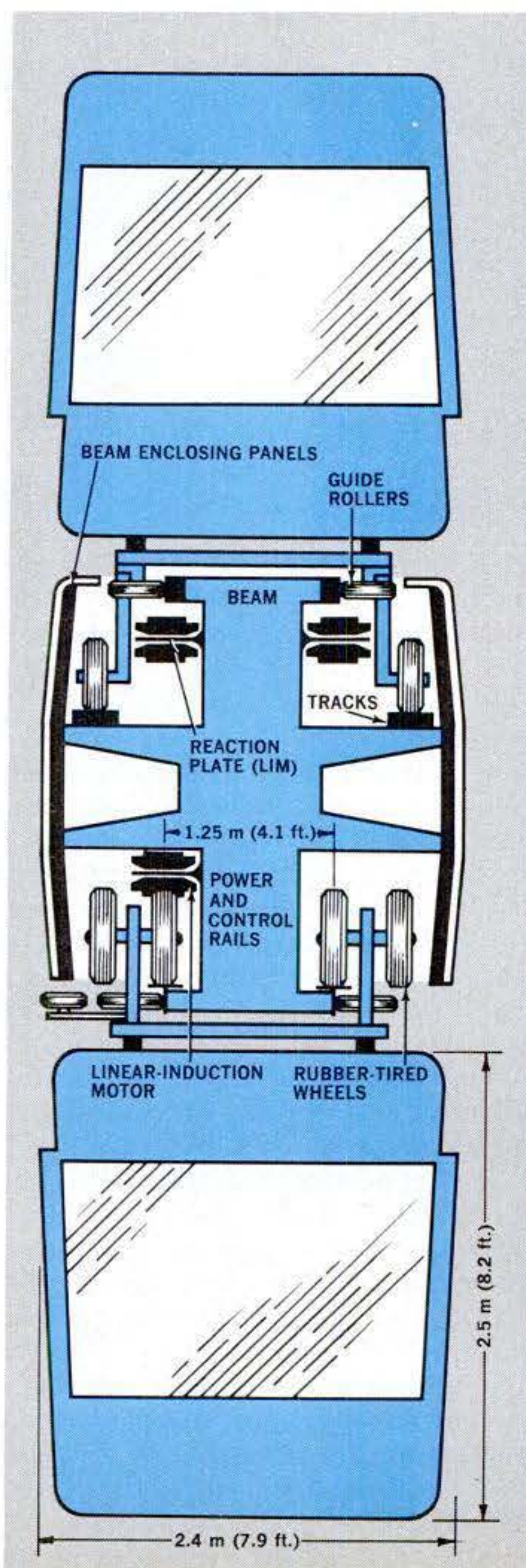
guidance tracks are fully enclosed within the beam. "This protects them from snow and ice," von Lieres said, "while the lateral rollers eliminate any risk of derailment. They allow tight corners—a turn radius as small as 100 feet—meaning greater versatility in urban routing."

Electric drive is from individual on-board linear-induction motors (see "Flying Trains," PS, Aug. '79). Power and flat reaction rails at both levels are completely shielded, so there are no weather or safety problems. Since traction does not depend on wheel-to-track friction, gradients up to 10 percent can be handled at full speed. The no-contact motors are also used for skid-free braking, supplemented by mechanical wheel brakes for parking and emergencies.

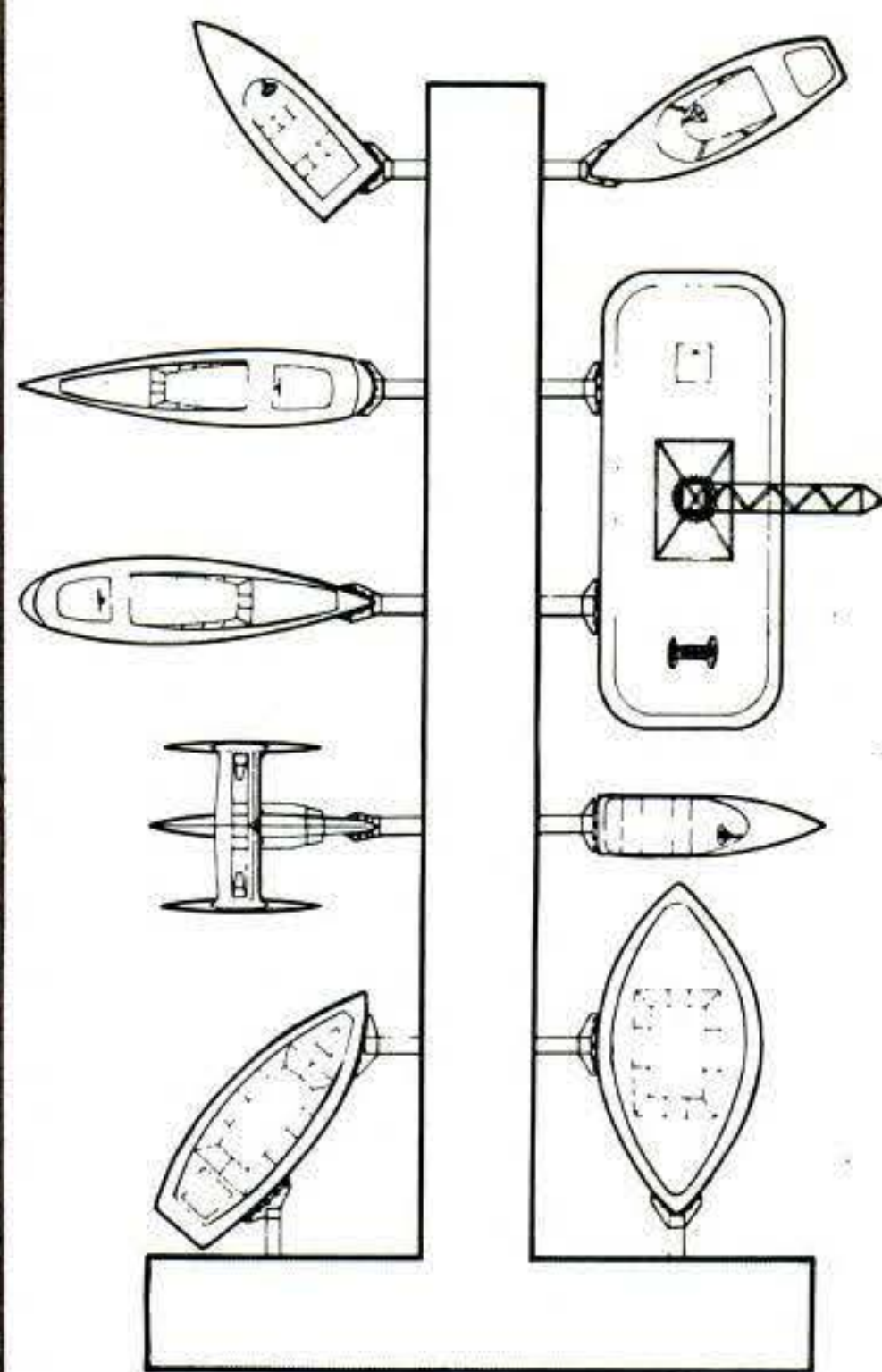
Switching at track junctions is done on the cars themselves by swiveling guide rollers, and is computer-automated. There are no moving points on the guideway needing regular maintenance or heating in winter. Cabintaxis move slowly but surely. MBB figures average travel times will be 50 percent shorter than by private car or other street vehicle in city traffic.

Tiny three-seat cabins only 12 feet long are planned for flexibility and economy on lines where traffic varies widely between peak hours and slack periods. These might be used on an extended 20-mile, 38-station network now envisaged for Hamburg.

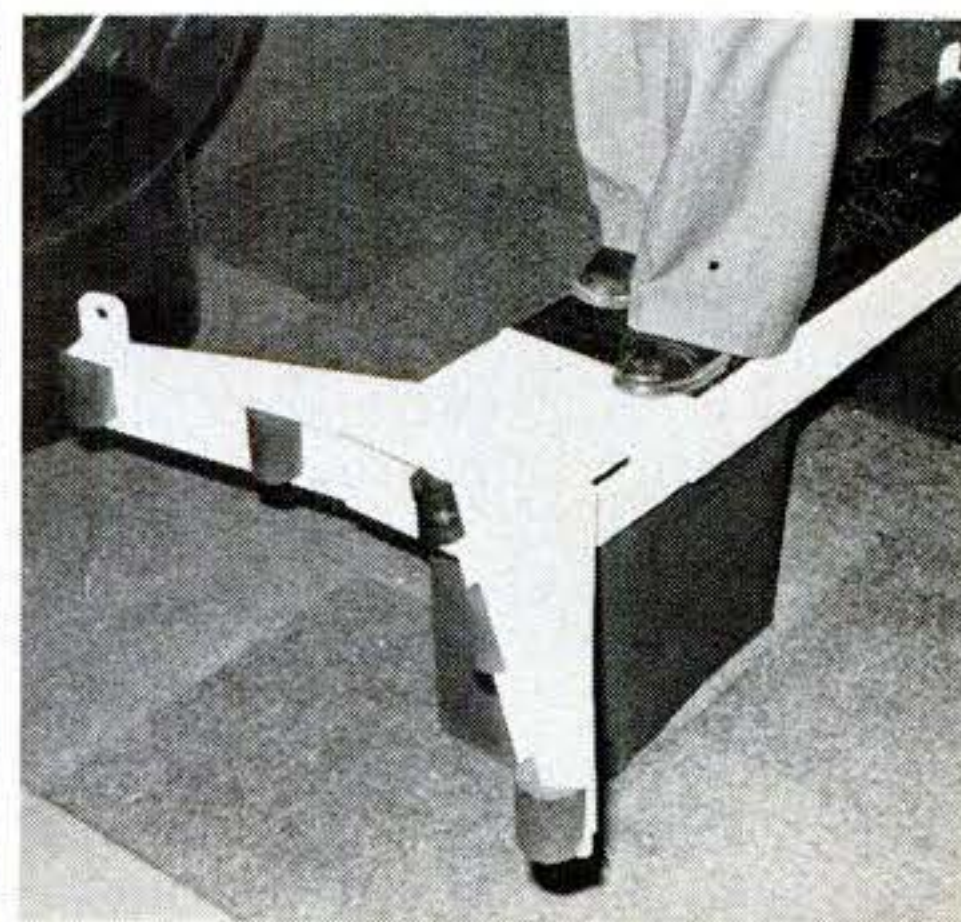
The individual monorail cars could do a lot to speed people and reduce road congestion in cities. They could be on call around the clock. The scheme is heavily funded by the German Federal Ministry of Research and Technology—which makes its chance of success pretty good. **PS**



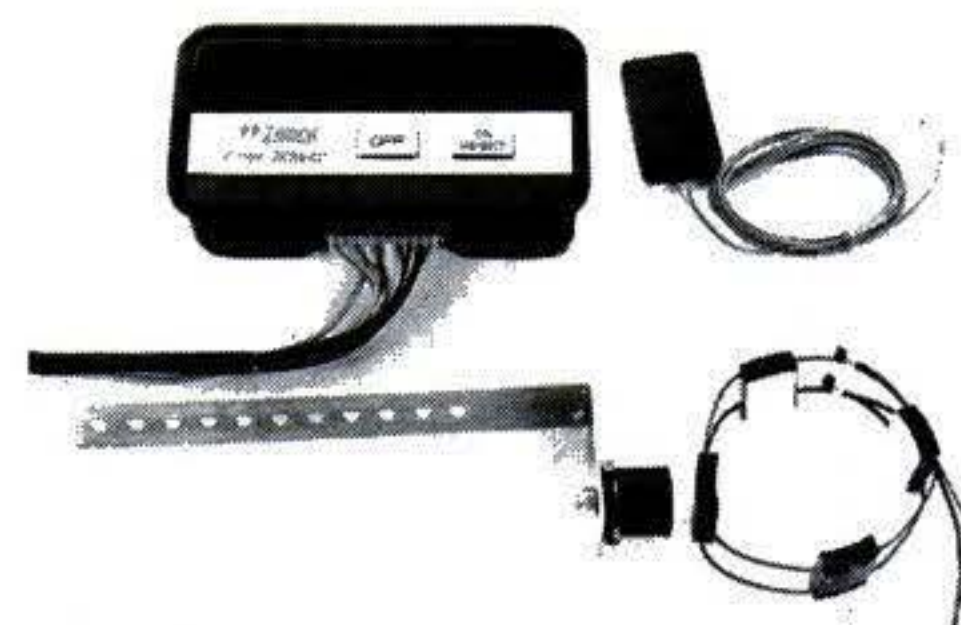
Telescoping pier for crowded marinas



Walking the plank can be delightful rather than deadly—if the plank is this telescoping gangway. Designed as a substitute for finger piers, the plank could open up overcrowded marinas. Hinged to the floating dock, the gangplank bobs gently in tune with a moored boat, just like a finger pier. Unlike a finger pier, the plank has two space-saving, pivoting arms that can hug any hull (see illustration). Rubber rollers act as fenders when the arms are leashed to a boat, and a spring damper in the walkway provides major cushioning action. One plank cradles most small boats, while two can moor larger or beamier craft. Planks with two sets of arms could be lashed between boats in crowded harbors, suggests the inventor (Jose Perez-Conde, 7 Places des Argonautes, 51100 Reims, France). This arrangement would safely separate the boats and provide a walkway between them.—David Scott



Stop-go fuel saver



Fuel Saver consists of control module, gas-pedal sensor pad with microswitches (upper right), and a motion-sensing coil (on bracket, below) that picks up pulses from magnets on rotating drive shaft.



Your engine goes off at red lights, on at green, to end fuel waste at idle

By **PAUL BOLON**

NEW YORK, N.Y.

A few moments after rolling to a stop at a red light on Fifth Avenue and 42nd St., my car's engine died. Instead of quickly turning the ignition switch, I did nothing—even though it was rush hour. When the light turned green I simply tapped the gas pedal. The engine started and I was on my way home.

For the past two weeks I've been driving an Audi 5000 equipped with a prototype of an engine stop-restart system made by Zemco Corp. of San Ramon, Calif. Zemco's experimental "Fuel Saver" turns the engine off whenever the car is stopped for two seconds, and restarts the engine automatically. Object: to save gas wasted when idling.

In 1975, when gas was in demand and lines at filling stations were long, the Department of Energy advised

turning your car's engine off to save fuel if you had a 30-second wait. But now we know that you don't have to wait that long to begin saving. That's why auto makers and federal agencies are very interested in the potential of the restart concept. It may represent the next big gain in fuel economy. (See the VW 2000 article in this issue.)

Tested on the 22½-minute-long EPA urban driving cycle, which has 15 idle periods of five seconds or longer, the Fuel Saver increased mpg by 7.5 percent, with a significant reduction in polluting emissions. It's believed that better results are possible in more congested traffic than that modeled by the EPA test.

Before driving with the Fuel Saver, I had anticipated problems in surrendering control of the car or, at least, annoying delays while restarting. But the system worked smoothly and was surprisingly easy to get used to. The two-second stop sequence is not begun as long as the car is even barely creeping along. Microswitches in a rubber pad on the gas pedal signal the system to restart.

The brain of the system is in the

dash-mounted module. It consists of some straightforward circuitry that monitors input signals from the car—brakes, engine coil, ignition switch—as well as its own internal timers and two sensors: the one on the gas pedal, and a coil that detects car motion (see photo). The program is somewhat more complex than simply stopping and starting the engine, however. It lets the engine warm up for three minutes and requires car movement before the first engine cutout. The program calculates the amount of fuel saved and displays it, and protects the starter motor by limiting cranking to 10 seconds. The Fuel Saver is disengaged by just pushing a button.

The program is being modified to restart the engine when the foot is lifted off the brake pedal. With this alternative, drivers who have manual transmissions in their cars won't have trouble when stopped on a steep hill; otherwise, the car might roll too much while the driver moved his foot from brake to gas and the engine started.

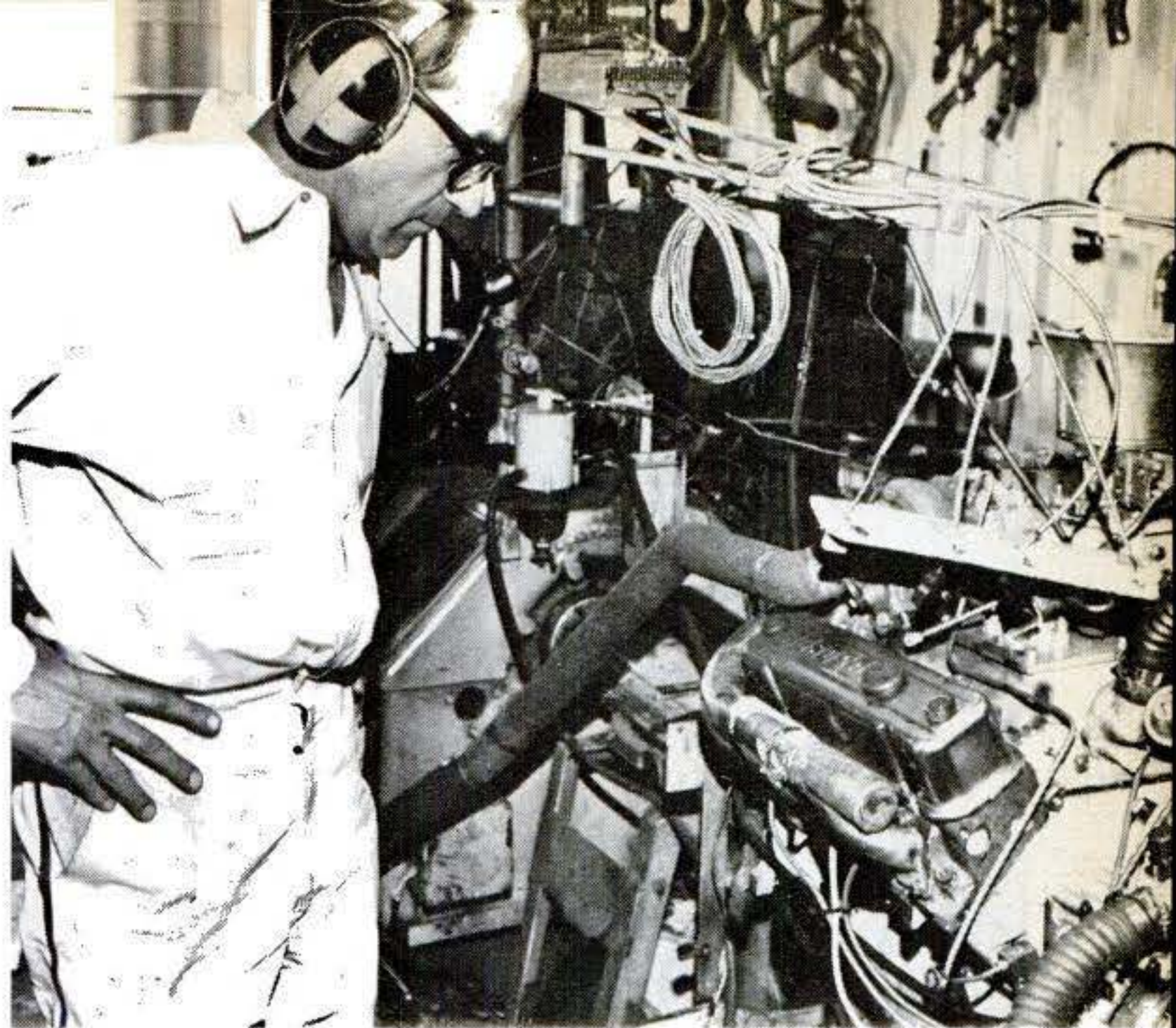
Frequent restarting will obviously multiply the work of the starting system. Auto companies report that this would at least accelerate maintenance required on the cranking motor. Zemco says that quick restarting of warm engines does not affect starter longevity nearly so much as long cranking of cold engines. However, auto makers may be reluctant to guarantee starters of cars equipped with a restart system.

Moreover, before the Fuel Saver can be sold, the Department of Transportation must allow bypassing the transmission safety lock, which prevents starting the car in gear. And it must pass tests of the California Air Resources Board and the EPA.

Auto makers are focusing their research on alternative restart systems such as flywheels and other energy-storage concepts. In coming months, PS will report on these projects and their impact on car design. **P 5**

Smokey's hot engines

— why Detroit looks to him for help on fuel-efficient engines



Smokey ponders the performance of a V6 engine running with only three pistons. Engine is a test rig for future designs.

Plasma-jet spark plugs and supertough silicon carbide parts may help save fuel

By E. F. LINDSLEY

DAYTONA BEACH, FLA.

I jumped back, startled, as Smokey Yunick kicked in what he calls "flame ignition." Right under my nose, a spark plug clamped to an engine bracket had been quietly snicking healthy—but strictly ordinary—blue sparks across the gap. Now, suddenly, the plug was cracking like a .22-caliber pistol. Each crack sent a flamelike burst torching out an inch or more from the plug tip.

This was plasma-jet ignition, similar to what I'd seen at the University of California at Berkeley [PS, Sept. '79]. Smokey, however, had it working in an engine, not a test chamber.

Smokey had clipped his handmade plug to the outside of the single-cylinder test engine so I could see the impressive difference between conventional high voltage and flame ignition. But that was just the beginning of Smokey's little show.

I watched as he snugged the same plug into the cylinder head and poured a few ounces of gasoline, diesel fuel, and methanol into the three small, individual fuel tanks that fed the carburetor. In the usual fuel-rating procedure, these tanks would hold the gasoline to be rated, plus isooctane and normal heptane. In this case, Yunick was using the handy setup so he could switch from one fuel to another with the engine running.

"I've got all three of these set way lean, about 25 to one, air to fuel," Smokey yelled above the noise as he started the engine. "None of 'em

would fire at all with ordinary ignition. Now, watch—I'm going to switch from gasoline to diesel and then to methanol." He flipped the handle on the valve, but the engine didn't seem to know it. Its steady beat went on regardless of the change of fuel.

Multi-fuel engine

What I'd seen was just one of Smokey Yunick's many research projects, aimed, in this case, toward developing an engine able to burn almost any fuel and do it with extremely lean mixtures. Later, I'll tell you about other experiments I saw that day: a V6 engine running powerfully on only three pistons; another V6 without cooling-water passages on one side of the block; and parts for Smokey's high-temperature—he calls it adiabatic—engine that he hopes will wring nearly every bit of usable heat energy from fuel.

Like components in a kit, these are all building blocks, eventually to be merged into Smokey's dream of smaller, lighter, more powerful engines that will use only half the present fuel per unit of horsepower, but won't require highly refined high-octane or high-cetane fuel. No such complete engine exists today, but, bit by bit, Smokey Yunick is coming up with the research results he needs to build it.

Such research is expensive. In addition to paying for the research and supporting the machine shop and lab, Smokey has to have sources for special—often exotic—materials. He needs experimental castings from which to machine parts, and many tests call for special one-of-a-kind items such as turbos, blowers, pistons, valves, and electronic gear. Obviously, Smokey has all of these. It's equally obvious that they were supplied by

Detroit car makers, major industry, and others willing to foot the bill.

But why Smokey Yunick? Couldn't the company engineers and labs do the same research? Don't they have every resource Smokey has and more? I'll admit that this was a puzzle to me. I'll also admit that the answers I found to that puzzle are mine alone. Others, even Smokey Yunick, might disagree or suggest other answers.

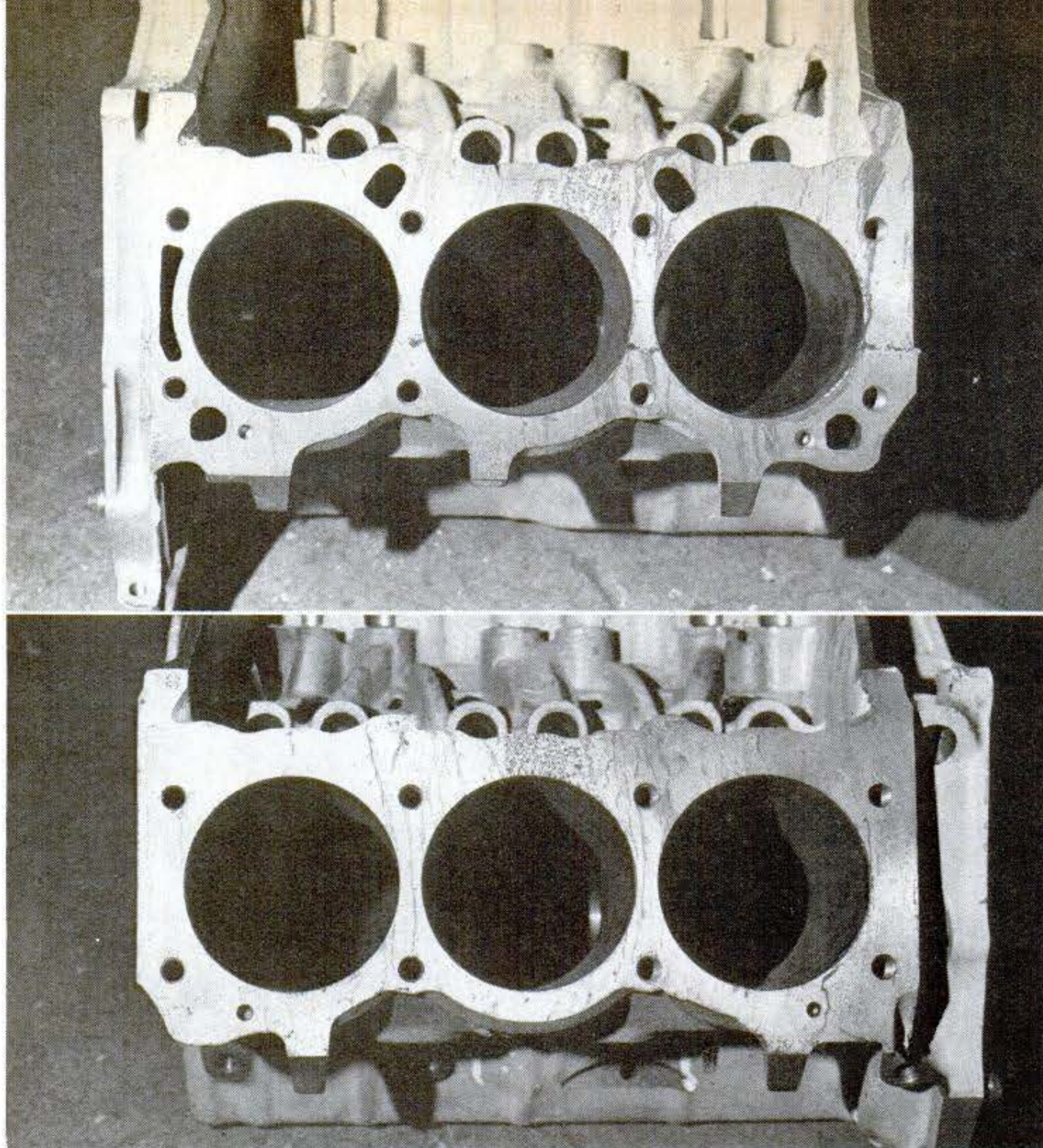
Black door

All of this research goes on in Smokey's sprawling, cluttered, private experimental shop. The ignition test I saw was set up just inside the locked black door that guards the shop. Outside that door and across the parking ramp are all the ordinary activities of what Smokey describes on his street-front sign as "The Best Damn Garage in Town." Out there, everything is being serviced, from big diesel 18-wheelers to gravel trucks, tankers, and pickups. Engines and brakes are being rebuilt, and all of the noisy, busy activity of a big automotive shop is going on.

But in here, even Smokey's cool, dark office is different from his business office. Instead of the racks of truck manufacturers' catalogs, price books, parts books, and business files, the walls are lined with textbooks.

I studied their titles, recognizing many of them. Clearly, Smokey digs deep into thermodynamics, chemistry, metallurgy, electronics, physics, and other topics too curious to list. Most of the book covers were stained by greasy hands. That figured. To know Smokey is to recognize the insatiable, driving curiosity that keeps him digging for answers. But all of Smokey's answers don't come from

Continued



Two banks of same V6 block were cast so one side (top) has usual cored water pas-

sages and other side is solid. Engine will test heat-resistant materials.

books. He has an absolute passion to call anyone, anywhere, without regard for corporate or academic position, if he thinks that person can furnish information he wants.

So when I asked Smokey how he managed to keep up with the engineers in Detroit, his answer was as direct as his street-front sign. "Hell, I've known most of these guys for 30 or 40 years. I've worked with 'em or for 'em in racing, development contracts, fuel tests, you name it." He thought for a minute and added, "You know, if I was on somebody's payroll in an engineering department in Detroit, I'd probably hesitate before I went calling around for information from every Tom, Dick, and Harry. If you're in the car business you don't necessarily want other people to know what you're thinking about. I'm free to do that."

Answers to why Smokey gets problems tossed at him by GM, Ford, and others, and why they don't handle such problems in their own plants, came in bits and pieces. One of those pieces of the puzzle fell into place as we left the ignition test.

Plasma-jet plug

I knew Smokey had studied the engineering papers on plasma-jet ignition, and I knew he'd talked to the uni-

versity professors and other experimenters. But then, in uniquely Yunnick fashion, he'd started from almost ground zero in electronics and designed and built the plasma-jet energy device and spark plug I saw.

The spark plug, like other plasma-jet plugs, had a cavity or recess in the nose about $\frac{1}{4}$ inch in diameter and about $\frac{1}{2}$ inch deep. But instead of steel, he used doped silicon carbide to make the nose both conductive and highly heat resistant.

As I'd seen, the little blue spark jumped from the center electrode to the cavity wall. His big, cracking spark, or flame, came from the electronic device that applied 30 amps at about 2500 volts to the center electrode. This voltage would not jump the gap itself, but when a conventional high-voltage, low-amperage spark fired across the gap, it ionized the air in the plug cavity and the high amperage came whacking across. Thus, all the plugs in an engine could be connected to the single high-amperage wire, but they'd only fire when the conventional, timed ignition source ionized the gap. In short, Smokey had two ignition sources: one timed high voltage to ionize the gap; the other, untimed high amperage to produce the flame effect.

Smokey's ignition system was fasci-

nating, of course, but even more fascinating to me was how Smokey had interrelated academic theory, freshly acquired electronic knowledge, and the novel characteristics of silicon carbide to produce a spark system such as the world had never seen before.

That was Smokey's special ingenuity at work. It's just not the kind of project you can assign to someone in a company lab and count on him to bridge all of the theoretical, metallurgical, and electronic gaps to produce a result.

Another piece of the puzzle dropped into place after I'd tailed Smokey's fast-paced stride through the maze of machine tools and parts shelves into the dynamometer room. He gestured toward a V6 engine mounted on the dyno and draped with instrumentation wires. "See that? We've been on this project for only 14 days, but we've got it running and already know a lot about it. They're working on the same thing in Detroit, but it'll be another three weeks before they even get the drawings made."

What Smokey was showing me appeared to be a fairly standard engine. It wasn't. He told me there were pistons in only three cylinders. I looked more carefully and spotted a large number of special hand-fabricated parts, adapters, and test components. I knew there were many more such parts inside. They'd been made in Yunnick's own shop.

My own industrial experience told me that getting such parts conceived, authorized, and dropped into a time slot to make design drawings, and then into another slot in the experimental machine shop to be built, would be a time-consuming affair. Getting it done in three weeks might even be a record.

Smokey projects

It wasn't hard to see why an auto executive who wanted to get a project moving would turn it over to Smokey. Smokey would make, modify, test,



Two silicon carbide valve lifters are samples of extremely hard, amazingly smooth parts made from this material. Pistons and other parts are on the way.

and reject parts, run up blind alleys and start over, almost overnight. He doesn't need committee meetings to make design changes, authorize procurement, or fight over who is responsible when something doesn't work.

It was along such lines that Smokey added another piece to my "why Smokey?" puzzle. Standing by the dynamometer just before he started up the three-piston V6, he said, "You know, if you keep doing and saying things and they don't work, after a while people don't believe you. But if most of the things you say turn out to be true, and most of the things you do turn out to work, people come back for more."

He gave the V6 a quick visual check and added, "I think this is going to work." It did. I watched the tachometer level off at 3600 rpm, and a check of the dynamometer showed 120 hp—not bad for three cylinders. Smokey said that he could have pulled 140 hp, but wanted to make some changes before pushing the engine.

If running only three pistons in a cylinder block made for six doesn't quite make sense, Smokey has a reason. Plainly, no one is going to put an engine in a car with three blank cylinders. But if you want to test some other things in a hurry and you've got a V6 block handy to start with, then you use it.

The test I watched showed that it was quite possible to pull a lot of power from three cylinders. In that respect, it gave Smokey a base line. How long the engine would last, of course, was not part of the test, because today's materials—cast-iron and aluminum—would eventually yield to high heat and pressure.

But there are better materials coming that won't be bothered at all. Smokey was base-lining and working out the details of balancing an engine with three pistons and rods missing. I soon learned why.

No cooling

That took another fast walk through the shop, this time to the area where he machines and bores cylinder blocks. Smokey jabbed a boot at a rough V6 block casting on the floor. It looked normal enough—until I noted that one bank didn't have the usual cored holes for water passages. Smokey bent down and tumbled the block around on the floor. "That's the next step," he said. "One side runs cooled with water; the other side gets no cooling."

I'd guessed by that time that he was talking about new temperature-resistant materials. Smokey confirmed my guess. "First we run silicon carbide pistons in silicon carbide sleeves in

the cooled side. Then we switch 'em over to the hot side." I understood then why he'd been working with three pistons: It gave him a research tool to get on with his experiments using exotic, superhard, high-temperature-resistant materials.

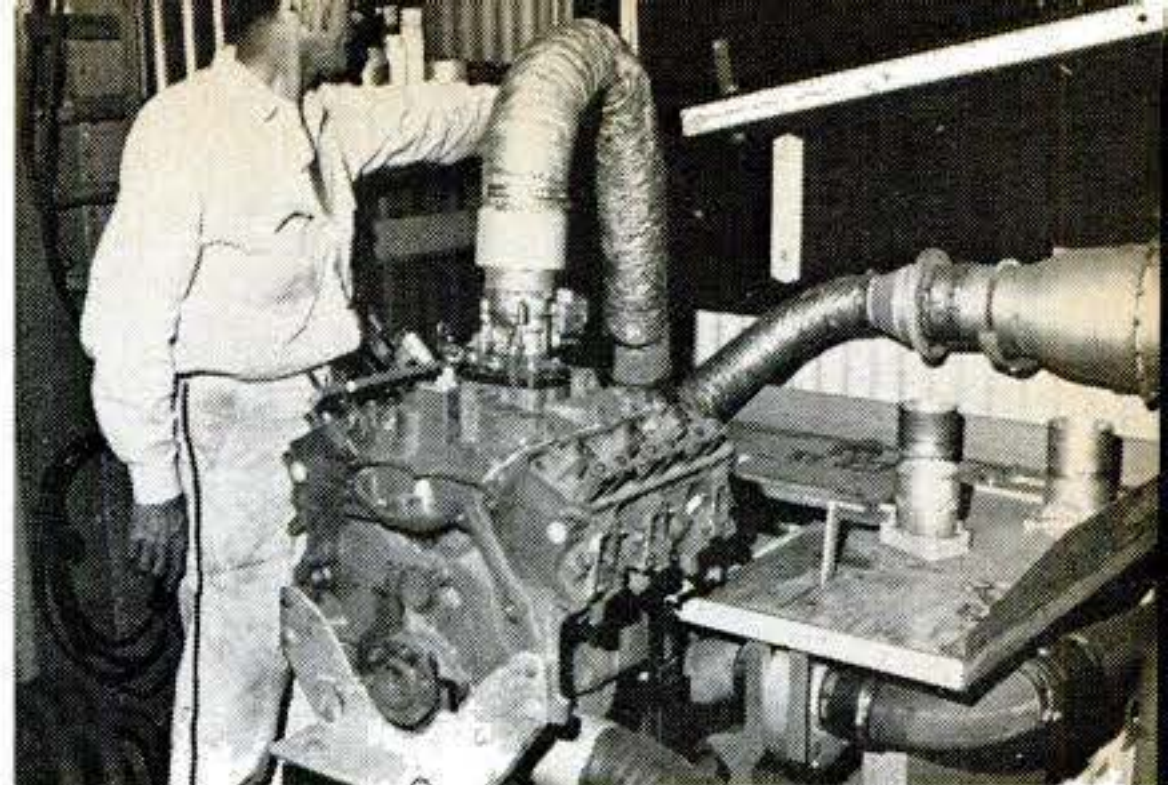
Unfortunately, the fact that he's deep into such research is about all that I'm free to report right now. Silicon carbide is almost as hard as diamond, but is easily machined in a certain state. It is inexpensive, requires no critical materials, resists extreme temperatures without distortion, doesn't corrode, and needs a minimum of lubrication. Smokey showed me some of the parts as he explained the material's advantages. When he's ready to talk about the engine he builds from it, PS will report it.

Today, there are quite a few companies in the picture that prefer not to talk. And that, of course, is another reason why Smokey is so useful. He can call around, persuade companies to supply him with special materials, parts, and knowledge, and serve as a confidential go-between for major firms without their being involved at the corporate level. Smokey is a master of industrial diplomacy. He's also very good at keeping his mouth shut.

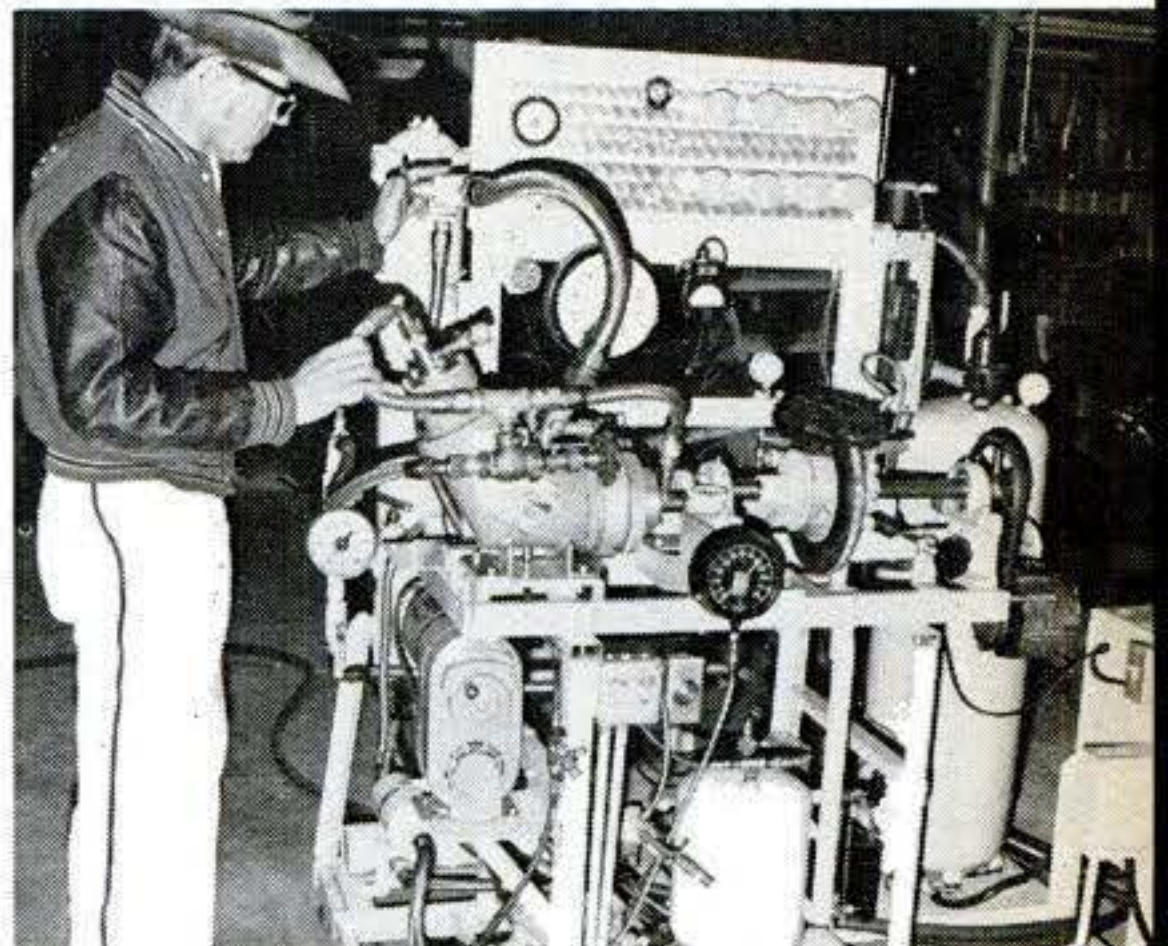
Wasted heat

But he does talk enthusiastically about getting more power from less fuel in the future. He recounts his experiences with racing engines: "Someone once told me how marvelous it was that I got 550 hp out of a Chevrolet engine. That isn't marvelous; that's disgraceful. We used the equivalent in heat energy of 2300 hp in gasoline. We made mechanical improvements, but the thermal efficiency was no better."

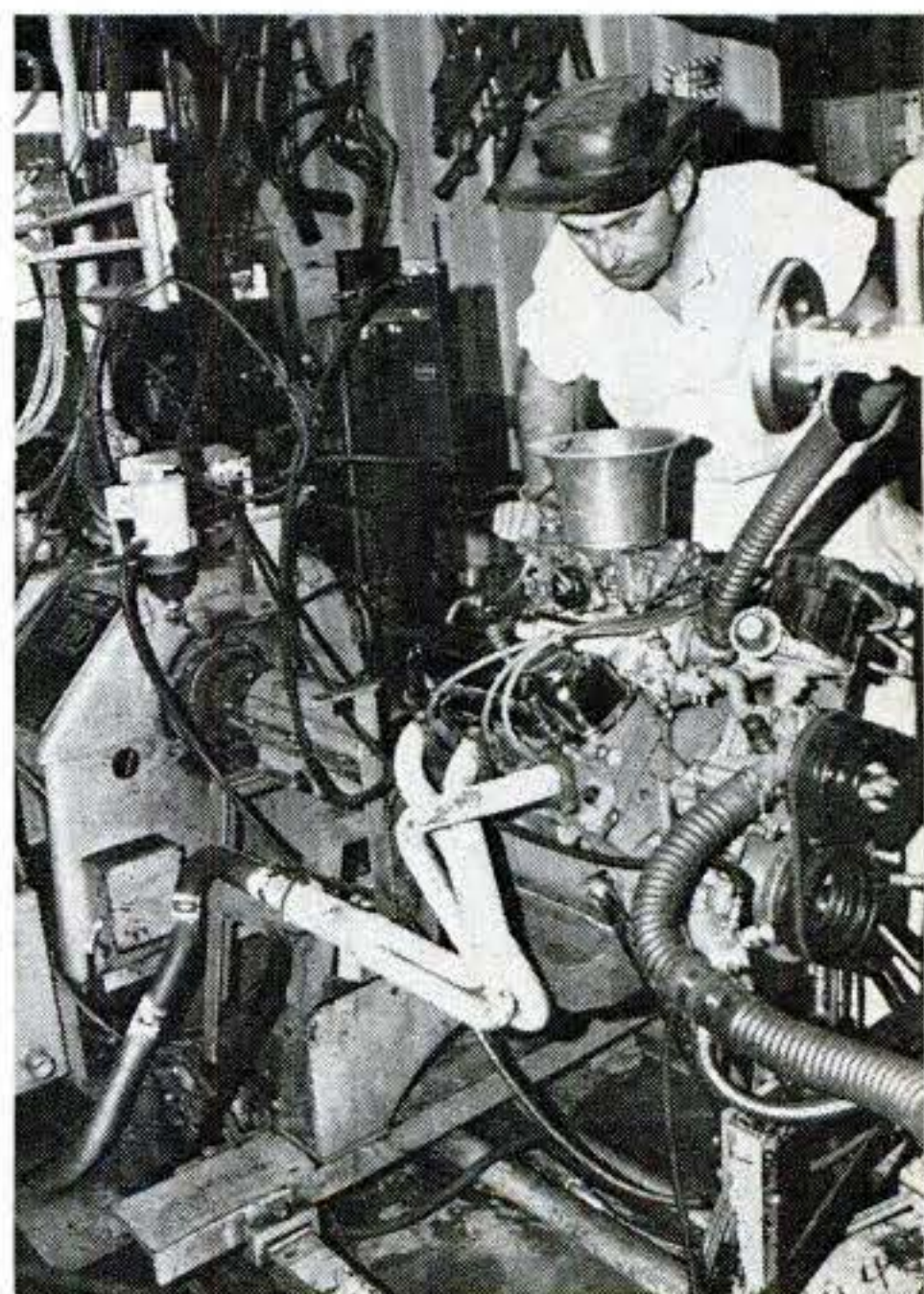
He continued, "The name of the game is heat. Right now we see heat energy pouring out of the exhaust pipe at 1600 to 1800 degrees F. I want to get that down to 400 degrees or less and put that wasted heat to work." He's even more disturbed about the heat wasted in radiators and oil coolers. "I have no intention of using a radiator," he says. His point is that if he can build an engine of materials that don't need cooling to keep them from melting or distorting, and don't need lubricants such as oils that oxidize when they get too hot, the heat can be put to work in the form of pressure rather than being dumped into the atmosphere. Equally important, if he can make almost any fuel run successfully regardless of its octane or cetane rating, as I saw him demonstrate, refining costs could be enormously reduced and we'd get lots more



Air flow through an engine is critical to performance. Smokey's flow setup has powerful blower, device for producing laminar flow, manometers for measuring flow, and the means to reduce it all to standard atmospheric values.



Oliver-Yunick steam engine, unusually efficient, is just one of Smokey's experiments in alternative power sources.



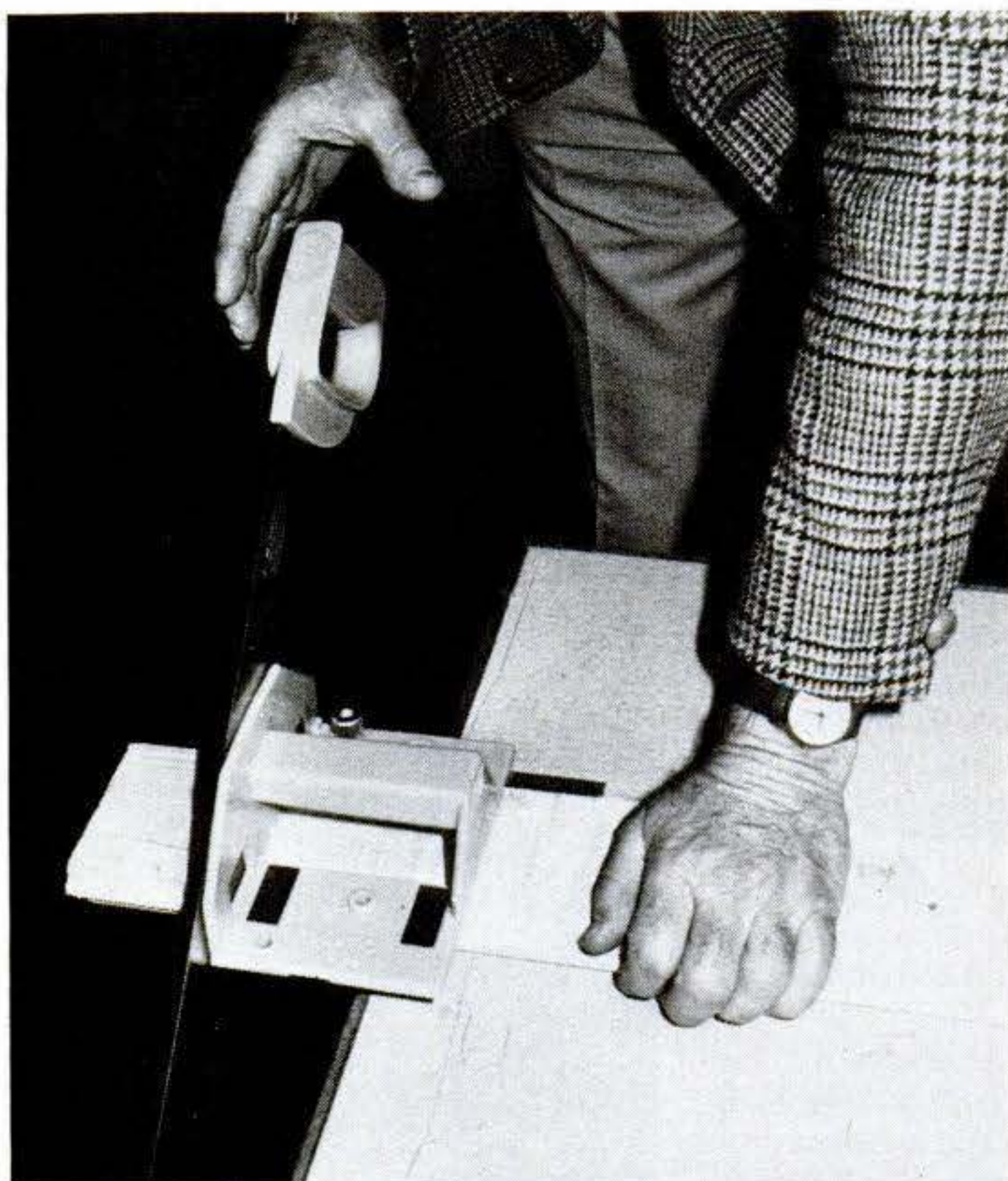
Dynamometer testing conducted by Smokey for a car manufacturer tests the efficacy of an engine modification.

miles per barrel as well as miles per gallon.

I'm eager to watch Smokey's progress, and from what I saw in his lab, some of the biggest companies in the automotive world are not only willing to watch, they're willing to supply what he needs and pay him to do it.

Ingenious ideas

from the Geneva Inventors Exhibition



Magnetic saw guide offers miter-box precision without the wobble. Small magnets, flush-mounted in the plastic fence, hold the saw in position (note the "no-hands" pose) without presenting much sliding resistance. Unlike miter boxes, the guide can be used with any work, no matter how wide. Abrasive pads on the bottom position the jig firmly on the wood. Downward pressure on the hand grip keeps work on the bench—with no risk to fingers. The fence is adjustable for 90- or 45-degree angles.



Color-changing plastic capsules assure consumers that frozen food hasn't thawed during shipping. The small telltales, visible through a window in the food package, contain two chemicals that are stable at deep-freeze storage temperatures. If the temperature rises above a critical level, the chemicals react, turning from white to yellow or red. Since successive near-thaws of the frozen food can activate some bacteria, the color-alert capsules also have a "memory." Large temperature swings affect their stability until a cumulative threshold is passed—then the color changes. Various chemical compounds can be used.



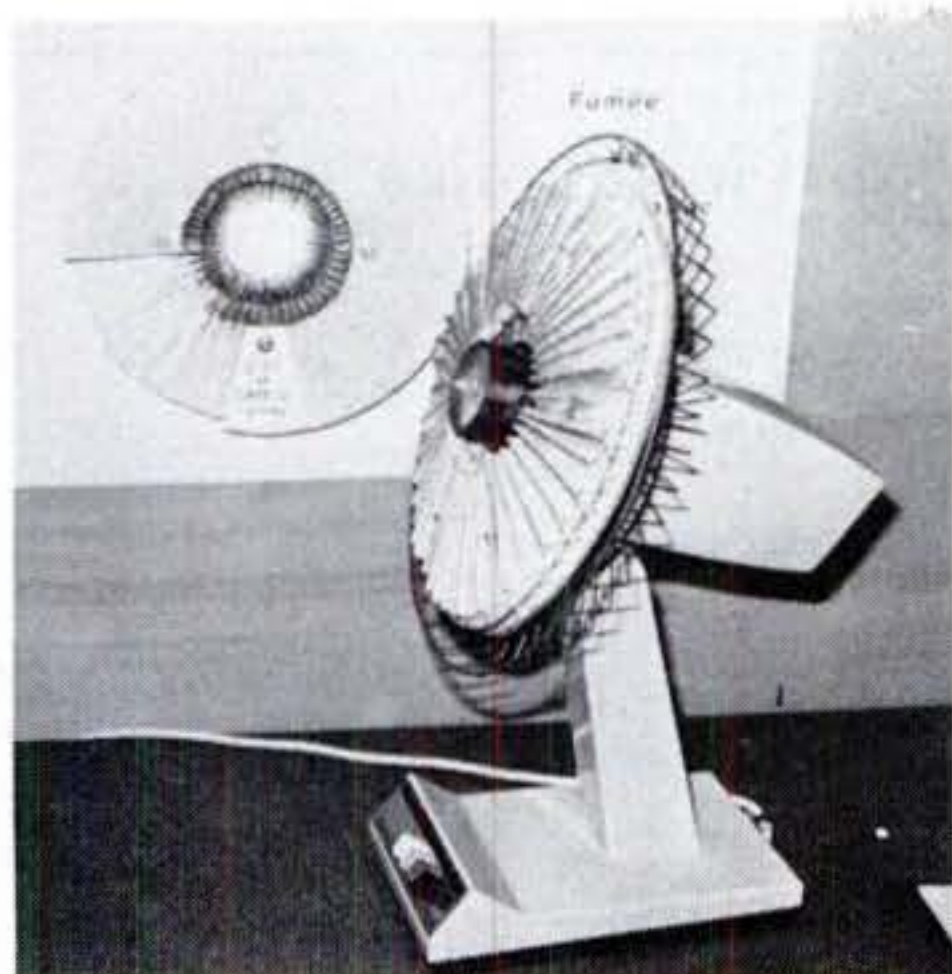
Wheel-changing aid minimizes the stress—and mess—of changing a flat. After jacking up the car and loosening the lugs, the driver slides the metal cradle under the wheel. A good shove on the handle lifts the tire off the hub and onto the rolling cradle for easy transport to the trunk. The cradle maneuvers the fresh tire as easily. And the tool's handle can be connected to a crank-type lug wrench for added leverage when loosening nuts.

By **DAVID
SCOTT**



Fiberglass canopy shields moped riders from wind and rain. The pivoting front panel clamps to the handlebars and fork; the rear section, its arched roof supported by the front pivot mechanism, clamps

onto the luggage rack or gas tank. Besides adding comfort, the white fairing makes the moped more visible, boosting safety. Heavy crosswinds might affect stability, says the inventor, but mild ones won't.



Air-cleaning fan has filters instead of blades. Layers of blotting paper crimped into radial ribs form the rotating filter. Centrifugal force pulls air sucked into the filter's open center out through the hollow ribs. The turbulent passage forces airborne dust, smoke, and soot against the filter paper, which traps them.

Combination ladder functions as both a stepladder and an extension ladder. Sliding pivot arms join the two aluminum sections, which can be braced open as shown for use as a stepladder. When a taller ladder is needed, the sections are pushed together so the grooved rear uprights can slide up along the pivot arms. Hooks on sliding member lock into other section.



Handy, two-piece snow chain clips on in seconds—without the wheel being rolled. Each section is made of two welded-steel, vertical braces connected by two tough plastic hoops. These fit over the tread and anchor the chains in place. After the matching sections are slid onto each half of the wheel they are hooked together at the top by a short length of chain. Lower ends are linked by a toggle-action clamping lever on one side that ensures a tight fit around the tire. The chain is said to give a good grip on snow, ice, and sand, and to run quietly on dry roads.



Heat-loss meter checks the thermal conductivity of insulated walls—from the inside of the building. The back of the handheld unit is a recessed, rectangular chamber rimmed with a rubber seal. Pressing the unit against an exterior wall cools the room-temperature air trapped inside the rear cavity. The temperature drop is measured for a 20-second period, timed by a start plunger depressed by the wall. The electronic meter automatically compares this temperature drop to the difference between indoor and outdoor temperatures previously set on the dial. Then it calculates the coefficient of insulation and displays it on the digital readout.



VW's stop/start 21st-century car

Volkswagen is trying advanced concepts now for 20 years down the road

By JAN P. NORBYE

DRAWINGS BY RUSSELL VON SAUERS

WOLFSBURG, W. GERMANY

When I lifted my foot off the gas pedal, the engine stopped and the car coasted silently to the red light. As the light turned green, I stepped on the gas. A tenth of a second later, the engine was running and we were on our way—yet I had touched no switches or handles; the process was fully automated.

"Shutting off the engine when its power isn't needed can cut fuel consumption by 20–25 percent in city and suburban driving, where frequent stops and starts are made," explained Volkswagen engineer Paulus Heidemeyer. As I continued my test drive of his firm's experimental car on the streets and test tracks around the research department in northern Germany, he briefed me on the car's fuel-saving drive train.

When we got back to the garage, Heidemeyer lifted the hood and pointed out the electronic brain that controls the two clutches at the heart of the automatic stop/start system. One clutch is a conventional type, working in its usual role between the flywheel and gearbox. But the other is a very special disc type, interposed between the crankshaft and flywheel. It disconnects the flywheel whenever you stop or coast. Simultaneously, the computer shuts off the ignition and fuel flow. The engine stops in 0.2 seconds and you save fuel until it restarts.

How does it restart itself? From the flywheel, which continues spinning

for a long time, even if the engine was doing no more than 2000 rpm when shut off. As you step on the gas, the system comes alive. The special clutch recouples the flywheel to the crankshaft, fuel is injected, the spark plugs fire, and you're off.

Looking forward

This system is part of a research program Volkswagen is conducting, financed partly by the German Federal Ministry of Research and Technology, and partly by Volkswagen's own funds. The project is called VW 2000, hinting at a year when a complete car containing all of the advanced features found on the experimental model might go into production.

In the U.S. EPA urban driving cycle, this car gave 10 percent higher fuel economy than one with a conventional power train of the same power.

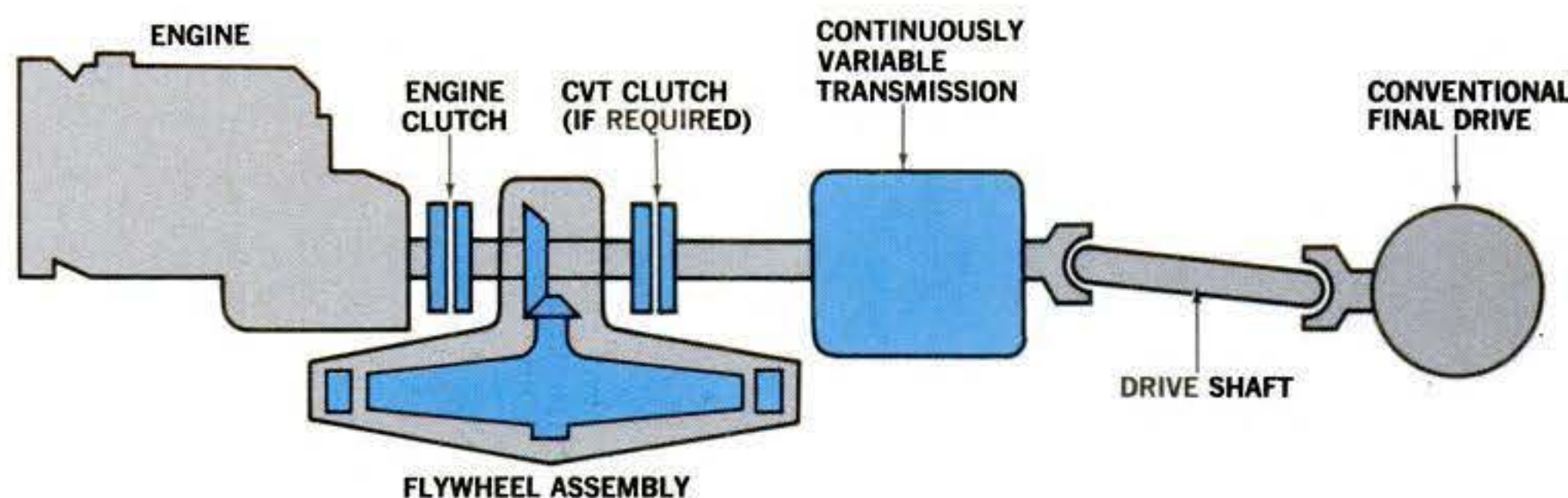
It also produced lower emissions, particularly important in city environments with their high pollution levels.

The car is the size of the contemporary Rabbit, but is much lighter and has lower aerodynamic drag. Various power trains of different performance levels are being evaluated. The test car I drove had an 1100-cc (67 cu. in.) four-cylinder turbocharged gasoline engine that delivered 70 hp at 6000 rpm.

The small displacement assures good fuel economy in city driving, while the miniature turbocharger provides power for rapid acceleration. Though the turbo comes in early during acceleration, it runs with a low 1.4-bar (20.3 psi) peak pressure, so the compression ratio can be kept as high as in an unsupercharged engine.

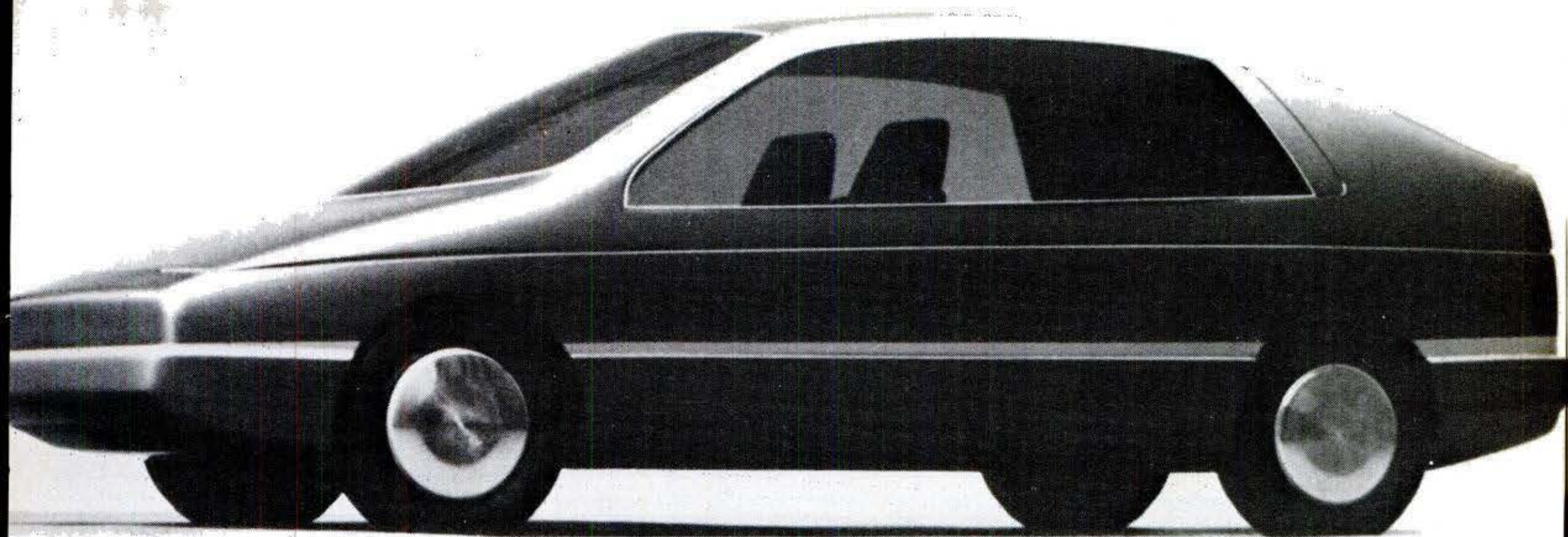
The car has a top speed of 110–112

Flywheels, CVT's, and stop/start in America



Flywheels, continuously variable transmissions, and stop/start technology all figure in what is perhaps America's most ambitious project involving internal-combustion engines and flywheels—but in the opposite manner from the German con-

cept. Where the Volkswagen design uses the engine for motive power and the flywheel to reactuate the engine, the American project uses the flywheel for motive power and the engine to reactuate the flywheel. Both projects, however, have the



mph and it accelerates from zero to 60 mph in less than 11 seconds. Its fuel economy? Between 40 and 44 mpg in composite driving cycles.

With an automatic transmission of a new type, fuel economy is projected to be around 36 mpg. This transmission has a low-slip hydraulic torque converter with a lockup clutch and a very compact four-speed planetary gearset. This may be only an interim solution, however, for Heidemeyer told me he is working on a stepless drive system based on the principle of a chain running between variable-diameter double-cone pulleys. He thinks this type is more realistic than traction-drive systems, which his research group is also investigating.

The automatic stop/start test car I drove has a five-speed manual transmission—but no clutch pedal. The conventional clutch disengages automat-

ically the instant your hand touches the shift lever. If your shifting is slow and you back off on the gas, the engine will sense this and stop, then restart as you move from, say, third to fourth gear. But it will do so smoothly. When coasting, you can engage in advance the gear you'll need to speed up again, and the engine will automatically take up the drive when you step on the gas.

Starting a long-stopped engine is accomplished by a special high-speed starter motor that turns just the free-wheeling flywheel. The engine springs to life only when you want to go. If the flywheel runs down while you're stuck in a traffic jam, the starter motor will automatically reactuate it. When you park, the engine-side clutch locks the flywheel to the crankshaft, so you can leave the car in gear to hold it on a hill.

(Because this system thus far has no provision for power-hungry accessories while the engine is stopped, it may not be suitable for cars with air conditioning or power steering. But with a car in the Rabbit's class, it should pose no problems.)

Other engines now under development include a methanol-fueled version of the same 1100-cc engine I drove. Because of the lower energy content of methanol, its fuel consumption is higher (17.5 mpg with an automatic transmission), although its total energy consumption is actually lower.

The diesel version wins the economy title, however, with 61.85 mpg in the EPA composite cycle. Volkswagen is also developing an experimental three-cylinder direct-injection diesel with the flywheel stop/start system.

Why three cylinders, rather than four of a smaller size? "We get less friction with three, as well as lower pumping losses," said engineer Eric Gaschler.

To come up with the new engine, the engineers cut one cylinder off the standard Rabbit-GLD block, on paper, and designed a three-cylinder aluminum casting with Nikasil-coated iron liners. Nikasil is a nickel-silicon alloy developed for the complex curved track of a Wankel engine, and gives an extremely hard-wearing surface. Along with the alloy block, a new crankshaft was designed, with crankpins spaced at 120 degrees for even power pulses.

"We then made up a new cylinder head with direct injection," Gaschler explained. "That gives 10–15 percent more miles per gallon than the swirl-chamber design of the current production diesel. We also use different pis-

Continued

same basic goal: substantially improved urban fuel economy.

The American project is being carried out at the University of Wisconsin, in association with Lawrence Livermore Laboratories and with funding from DOE. Directing the work at Wisconsin are professors Norman H. Beachley and Andrew A. Frank. Their first demonstration car, to which they added fuel injection and a drive train similar to the one illustrated, boosted EPA city economy from 22 to 32 mpg. The current plan will make use of a Chevrolet Citation and one of two new-design CVT's. Computer projections indicate that this will boost economy from the EPA's 24 mpg to around 50 mpg.

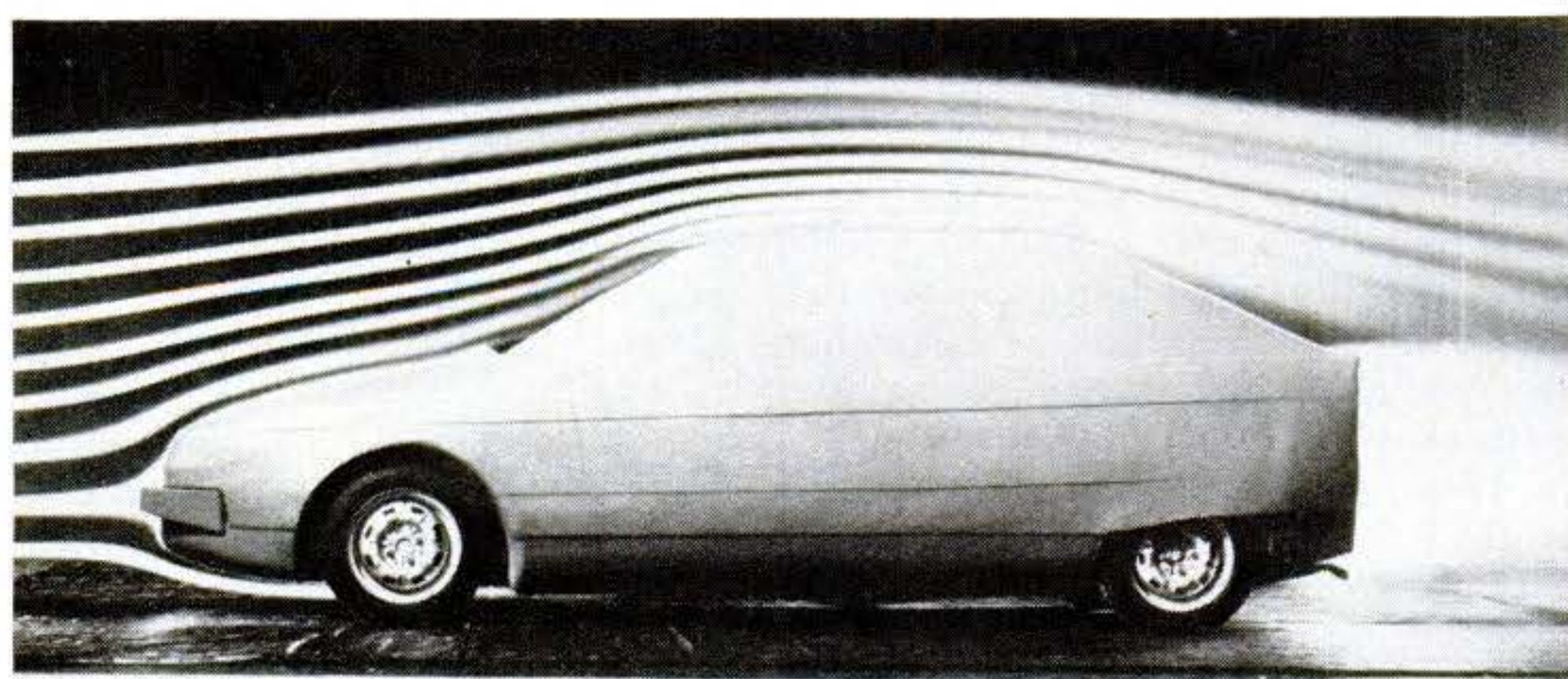
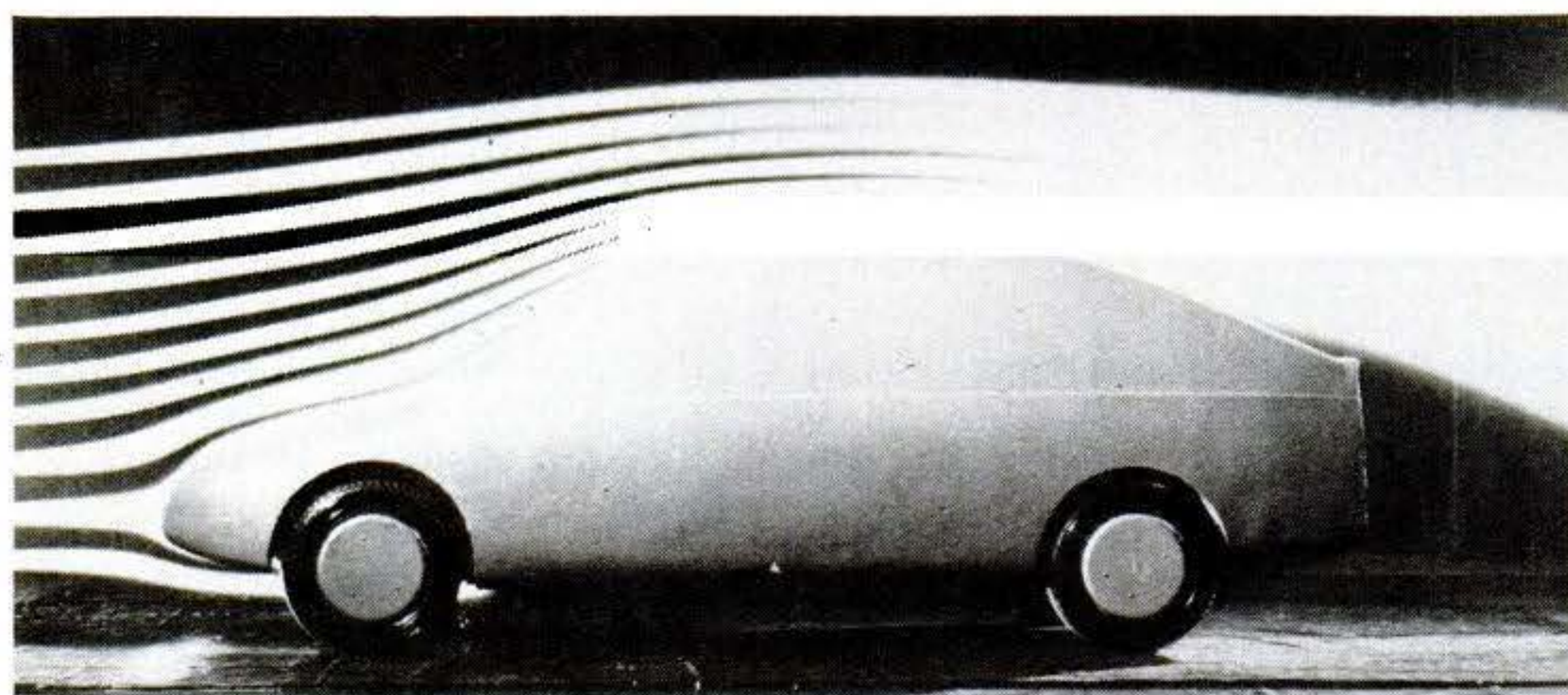
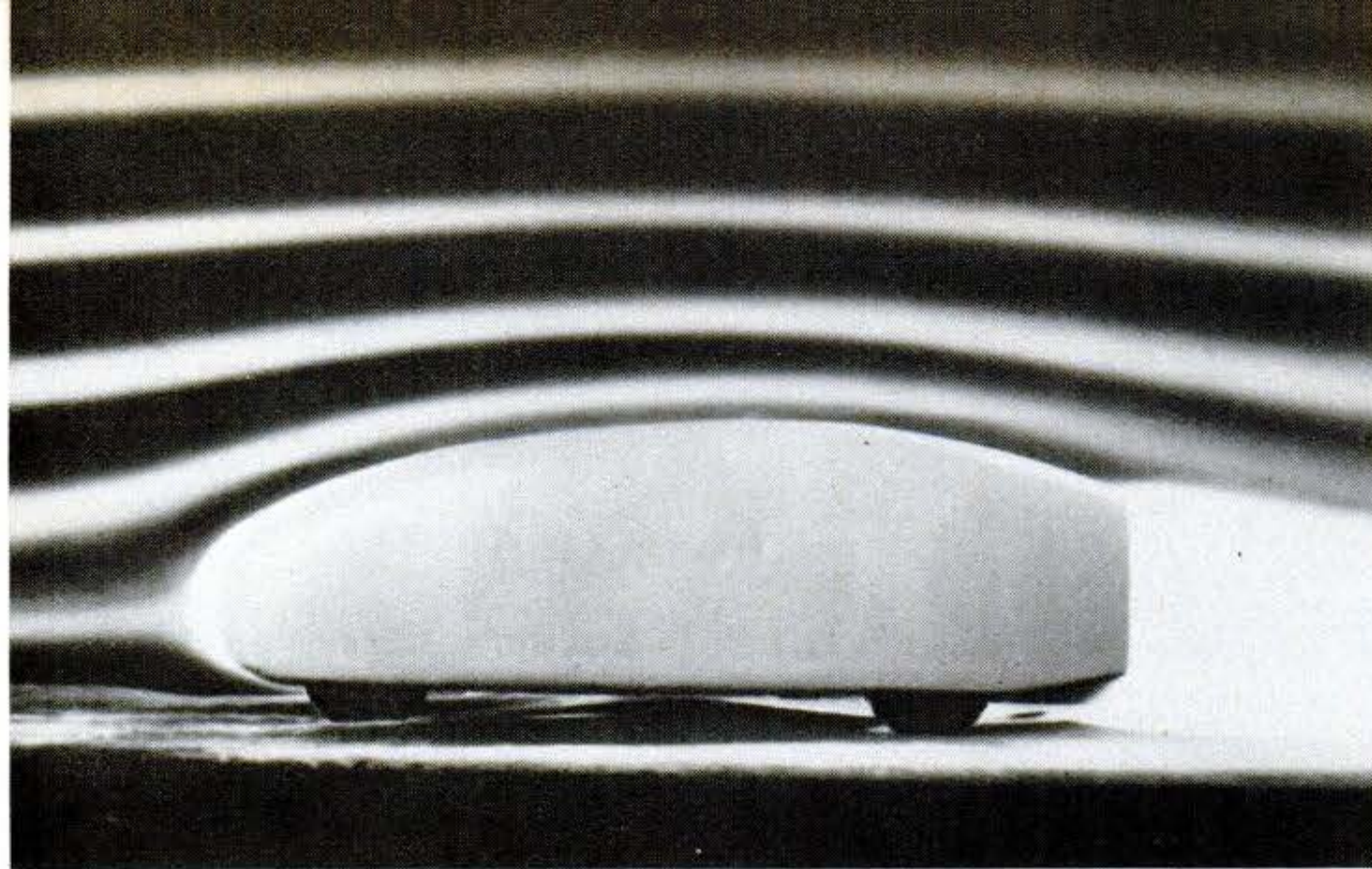
Like the German project, the stop/start function is mainly for the city—but the engine could be off at any time, since the flywheel powers the car and the engine runs (at peak efficiency) only to accelerate the flywheel. Over about 45 mph, however,

the engine would power the car, since it would run quite efficiently with the CVT.

A van Doorne Transmatic CVT [PS, June] is currently favored, and will be tested in conjunction with a two-speed gearbox giving both the standard 4:1 variable ratio range and a more efficient 16:1 range. Also getting serious consideration is a 12-speed slipping-clutch gearbox.

Packaging the concept in a front-wheel-drive car like Citation will be more than just technically interesting. Beachley and Frank feel that the car will be more stable during regenerative braking.

Flywheel development at the Univ. of Wis. will benefit from activity at Lawrence Livermore and AiResearch. Current projections call for a storage capability of 1/3 hp-hrs. in a package weighing about 50 lbs. To get the project rolling as soon as possible, though, a simple but heavier steel flywheel may be used. (Also see "Start-Go Fuel Saver," this issue.)



Wind-tunnel photographs trace development of the VW 2000. The blunt, flat-tailed bullet on wheels (top) was developed from a 1922 design by W. Klemperer of the Zeppelin works. The intermediate design (center) had a more car-like shape,

but lacked proper space for drive train and failed to meet several safety requirements. The basic model for later, fully stylized versions (bottom) meets practical and legal requirements, and has a remarkably low drag coefficient of only 0.24.

tons, with a deep-dish recess in the crown and a central peak that preserves swirl. Next, we curved the intake runners to generate swirl in the port areas, giving the necessary turbulence inside the cylinder to assure proper atomization of the fuel sprayed in."

Instead of a turbocharger, which would be effective only at high speeds, the three-cylinder diesel is equipped with a mechanically driven supercharger, which delivers boost pressure from the lowest rpm. Experi-

ments are concentrated on a positive-displacement vane-type compressor, but the rotating-paddles Roots-type blower is also under consideration. Unfortunately, both are rather bulky and heavy—and it was mainly to offset extra weight that the three-cylinder's block was made of aluminum. The blower drive is fitted with a clutch that disengages when boost is not needed, and goes into action in response to throttle kickdown.

The diesel delivers 42–43 hp at 4000 rpm, instead of the 35 that would

be its peak without supercharging. This gives the car a top speed of 87 mph and zero-to-60-mph acceleration of less than 20 seconds.

All engines are being developed to meet expected emissions standards. The diesel, gasoline, and methanol engines will emit less than one gram per mile of oxides of nitrogen (NO_x) and less than 0.6 gpm of particulate emissions.

Cutting weight and drag

But the VW 2000 isn't just a fuel-efficiency project that delivers low emissions. It is also a practical four-seat sedan, built on the Rabbit's wheelbase and designed with due regard to safety considerations (pedestrians' as well as occupants') and production costs.

Many of the safety ideas from the ESVW II and IRVW prototypes [PS, Oct. '77] are part of the VW 2000. They include the fork-frame reinforcement of the body shell, a soft nose, and passive seat belts—but no air bags.

"The main body shell is a steel structure with hang-on subassemblies," Harald Schimkat told me. Together with Andreas Bauer, he is in charge of body engineering for the VW 2000. Their concern for lightness is evident throughout the car. Their primary approach was to reduce surface area and, at the same time, retain interior volume (including the trunk space).

With less surface area, less material is used for a given package, and that saves weight. The secondary approach is materials substitution, using light alloys or plastics in place of steel. The opportunities for such substitutions in the body are obvious, and many car companies have already begun to use plastic for door panels, hoods, trunk lids, roof panels, wheel arches, and other unstressed parts. Plastic substitutes are also being used in bumper systems.

Volkswagen engineers are also looking at making chassis parts from lightweight materials. The fuel tank, for instance, can be made from plastics, as has been common on racing cars since the mid-'60's. "We can make the whole rear axle in plastic," said Bauer, "but it means a total redesign. The axle will no longer look the same, and such a redesign will affect its attachments and other parts in the same area. It really goes throughout the whole car."

Once a satisfactory plastic rear axle has been developed, the same techniques can be carried over to other parts. How important can materials substitution become? "A 17 percent weight reduction in the body and

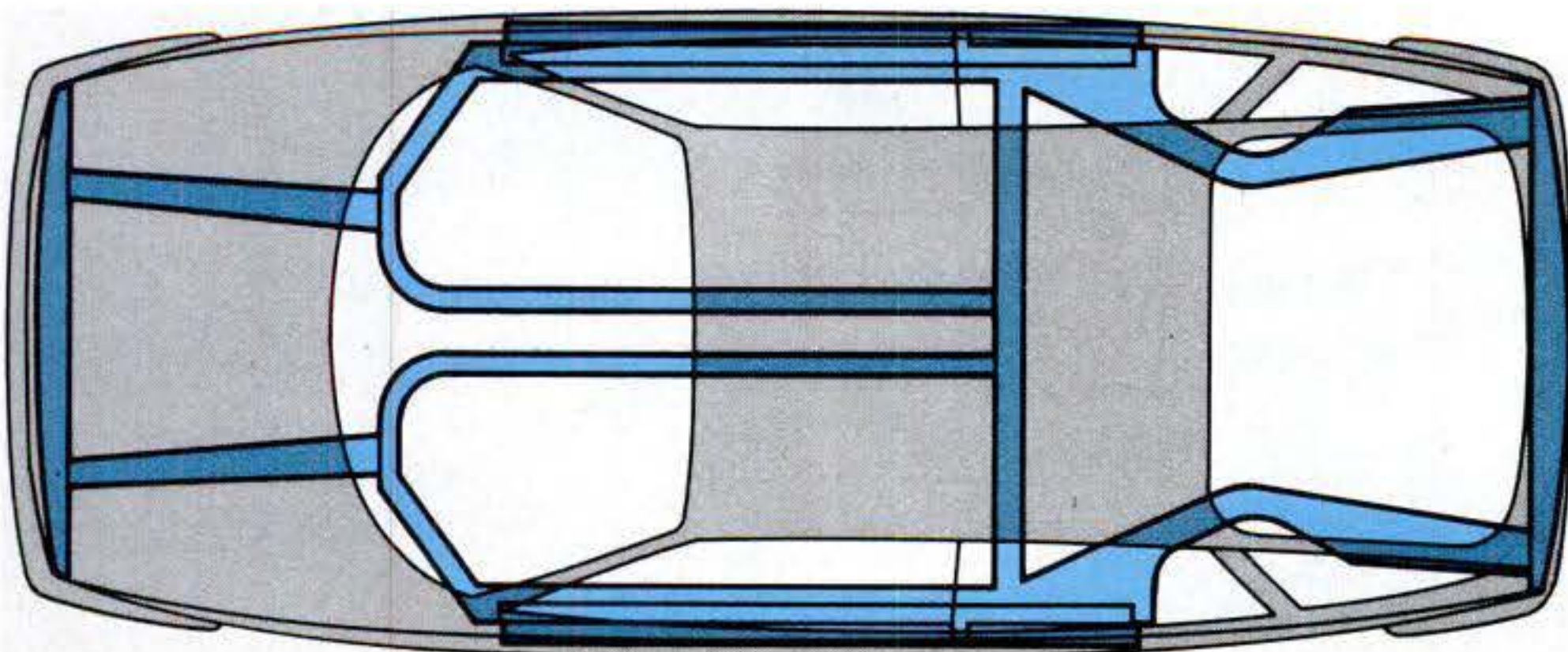
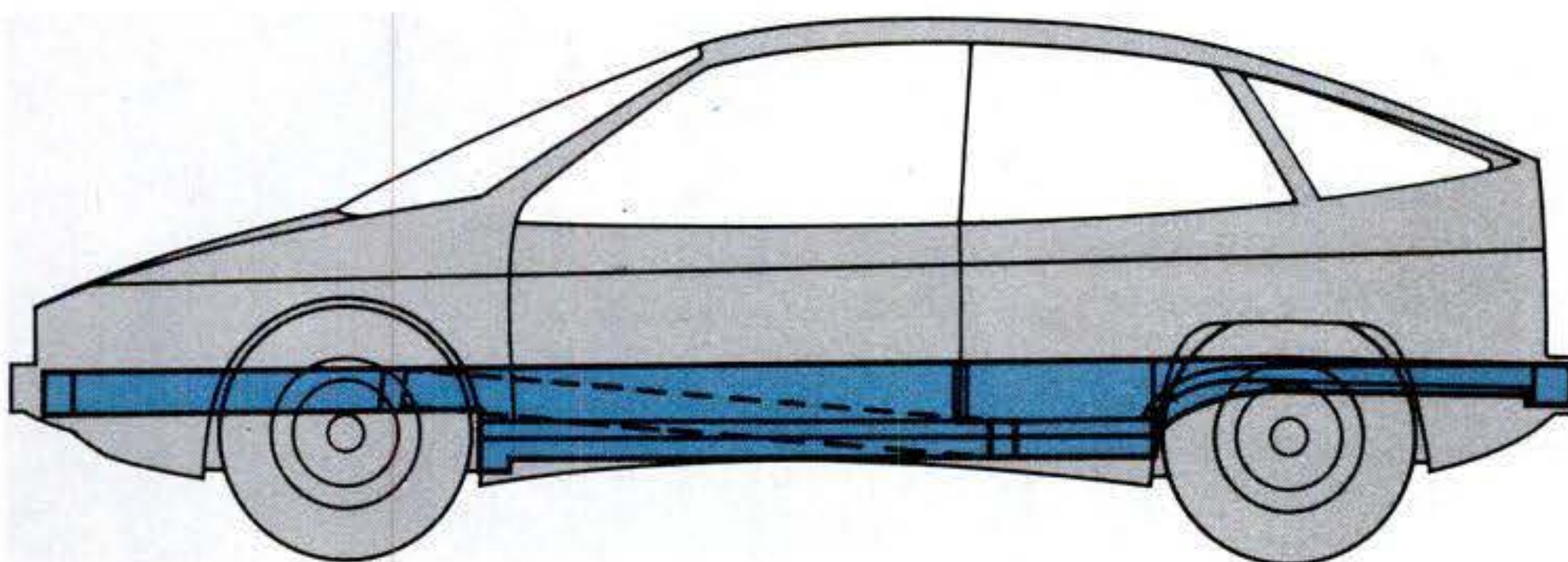
chassis of the production-model Rabbit is a realistic target," Schimkat observes. That would mean lowering the steel content in the total car from 69 to 50 percent, and raising the plastics content from 10 to 18 percent. Simultaneously, the aluminum content would go from about three percent to 11 percent.

Body shape is extremely important for overall fuel economy, due to its effect on air flow. With today's production Rabbit, for instance, half of the power necessary to cruise at 40 mph is used just to overcome air drag. Further, adds VW wind-tunnel chief Rolf Bucheim, "Between the worst and best among current cars of all makes, there's a 15 percent difference in gas mileage that can be traced to aerodynamics."

Total air drag is the product of the frontal area and the drag coefficient. "If you start with the Rabbit as your base, frontal area is not reducible," concludes Bucheim. Consequently, the drag coefficient (0.42 for the Wolfsburg-built Rabbit) must be lowered. He claims a 30 percent drag-coefficient reduction is possible, "in a variety of shapes and fully practical bodies."

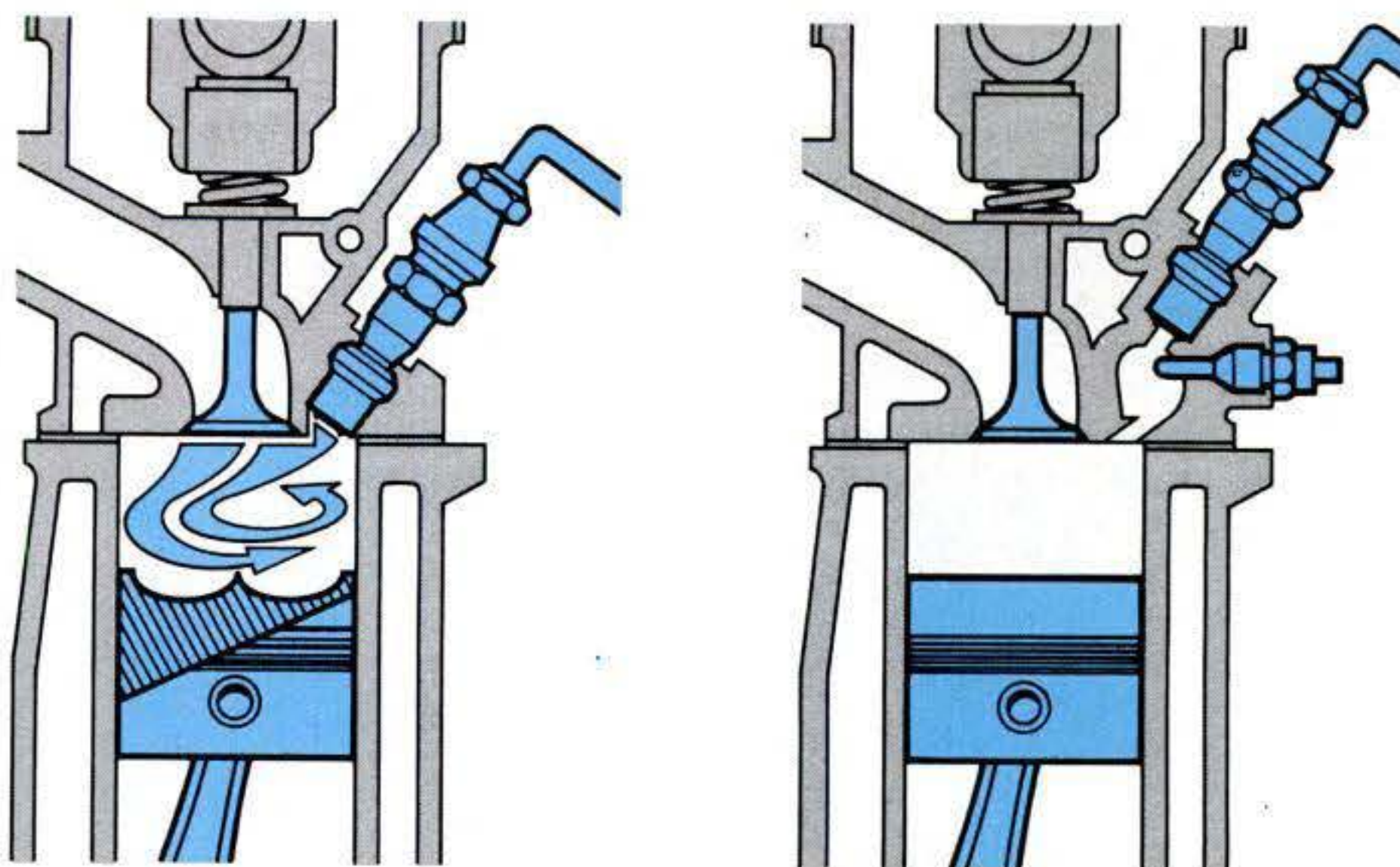
With that in mind, the VW 2000 started not as a designer's concept, but rather in a wind tunnel. A suggested ideal body form dating back to the 1920's was the starting point. Its drag coefficient (C_D) was found to be 0.15. This shape was shortened and adapt-

Fork-frame concept



Impact forces are absorbed on a single plane, with controlled crush front and rear. Wraparound central sections provide rigid passenger protection.

Comparing experimental and production diesels



Experimental engine (left) lacks prechamber and glow plug of production unit. Fuel is injected directly into chamber. Swirl for

better fuel/air mixing comes from curved intake runners and deep-dish, central-peak design of the piston.

ed to the Rabbit's wheelbase, then honed to a C_D of 0.16.

Next, it was redesigned from a theoretical shape to a somewhat practical car. After a variety of intermediate hoods, roof lines, and tail configurations, a C_D of just 0.18 was achieved. But that shape failed to meet legal requirements, and was unworkable for several reasons: Underhood space was unsuitable for engine installation, the windshield angle produced intolerable

refraction and visibility problems, and the high tail caused rear visibility difficulties.

A lot more time and wind-tunnel work led to a model with a drag coefficient of 0.24. But that's still just for a basic, practical model—no more. It was created with no real thought to styling or ease of production. It must be seen as the starting point for the styling and body-engineering departments, each of which will cause some rise in drag. The large photo on the opening spread shows one of the stylized versions derived from the basic model; others are in the works, all of them with drag coefficients below 0.30.

"You can see how it all goes together," says Dr. Peter Walzer, a leading thinker in VW research. "Weight savings are additive to the energy savings of the low-drag form. Because the car is lighter and disturbs the air less, its power requirement is lower, and performance can be maintained with a smaller, lighter, more economical engine."

Will Volkswagen produce the VW 2000? Probably not as it now exists, because further research will constantly refine car design as time goes by. But you can expect major elements of it to show up in future VW production cars—from now through 1990. The three-cylinder supercharged diesel is technically feasible today; the automatic stop/start system is a near-term possibility. In addition, future Volkswagen bodies will show the aerodynamic lessons from the VW 2000 program, and new materials will be incorporated as they become cost-efficient.

What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Smart phone

Drop coins in this "smart" British pay phone and a microcomputer goes to work. A display shows the amount of money inserted. The computer deducts two-penny increments as time runs out. It also returns coins for unused time, or stores unused credit for the next call.

Advanced-design features

A drag-reducing front spoiler on Volvo's "concept" car retracts automatically at speeds under 40 mph, when it has little aerodynamic effect and could be damaged by curbs or deep snow. An electronic memory for the power-adjusted driver's seat is another feature that may turn up in future models: Push a button (above, right) and the memory recalls seat positions for four people. The dash has small CRT's for function and warning displays. A two-liter engine with fuel injection is turbocharged to deliver 136 hp and meet California's emission standards.



Ocean reel

A one-piece tubular frame gives its new Triton ocean reel exceptional strength, says Shimano. The one-piece machined-aluminum spool resists distortion when the big ones put up a fight. Shimano American Corp., 205 Jefferson Rd., Parsippany, N.J. 07054.



Crack detector

Divers hold this ultrasonic scanner against offshore oil platforms or other steel structures to help detect cracks and faulty welds. Sonic echoes cabled to a ship are mapped on video monitors. It was developed at Harwell, research lab for Britain's atomic energy agency.

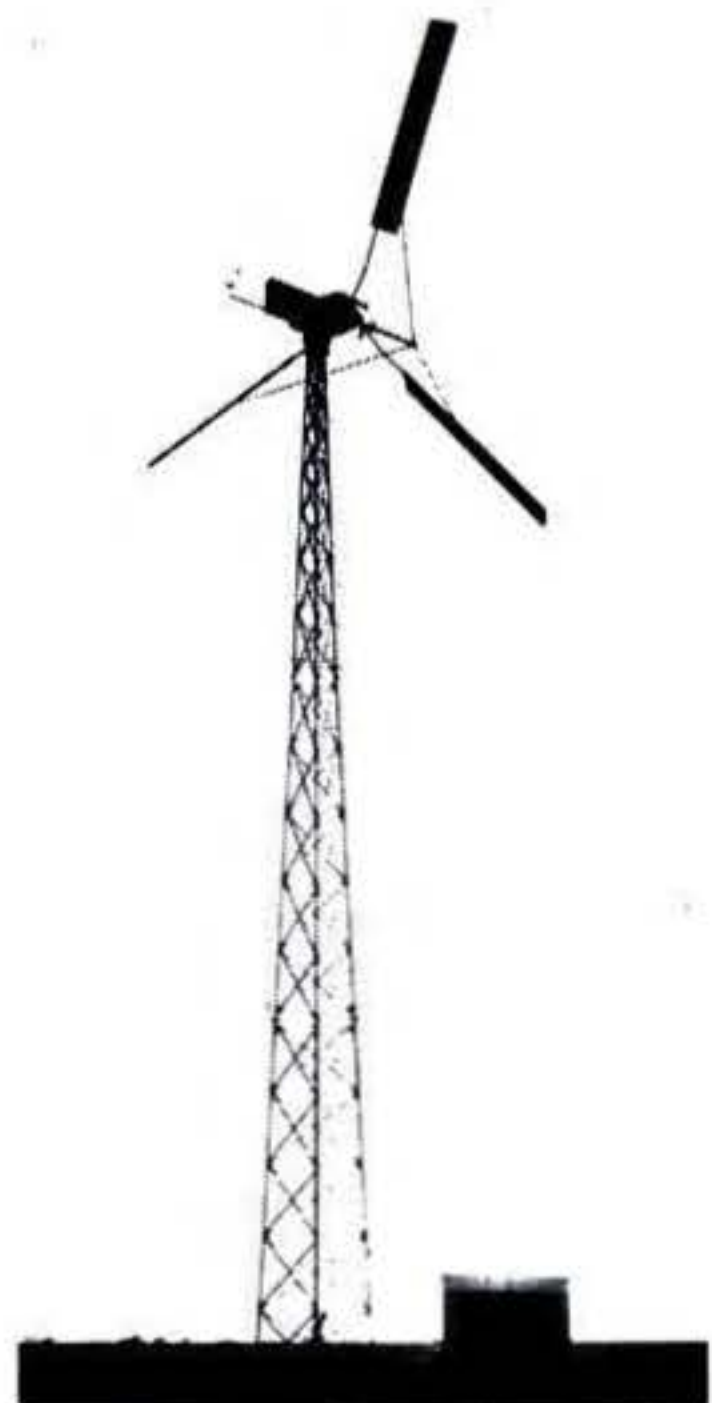
Bike motor

Add the 12-pound Streamline Tas to any bicycle or adult tricycle, and the two-cycle, 1.2-hp motor provides a 20-mph cruise speed (16 mph for trikes). Fuel economy is 300 mpg, says the maker (Palmer Industries, Box 707, Endicott, N.Y. 13760).



F-16 canards

Large maneuvering canards jutting into the airstream beneath the cockpit may help F-16 pilots survive missile attacks. A fighter modified with canards and advanced electronic gear will be flown next year. The Air Force wants to boost aircraft survivability and attack efficiency.

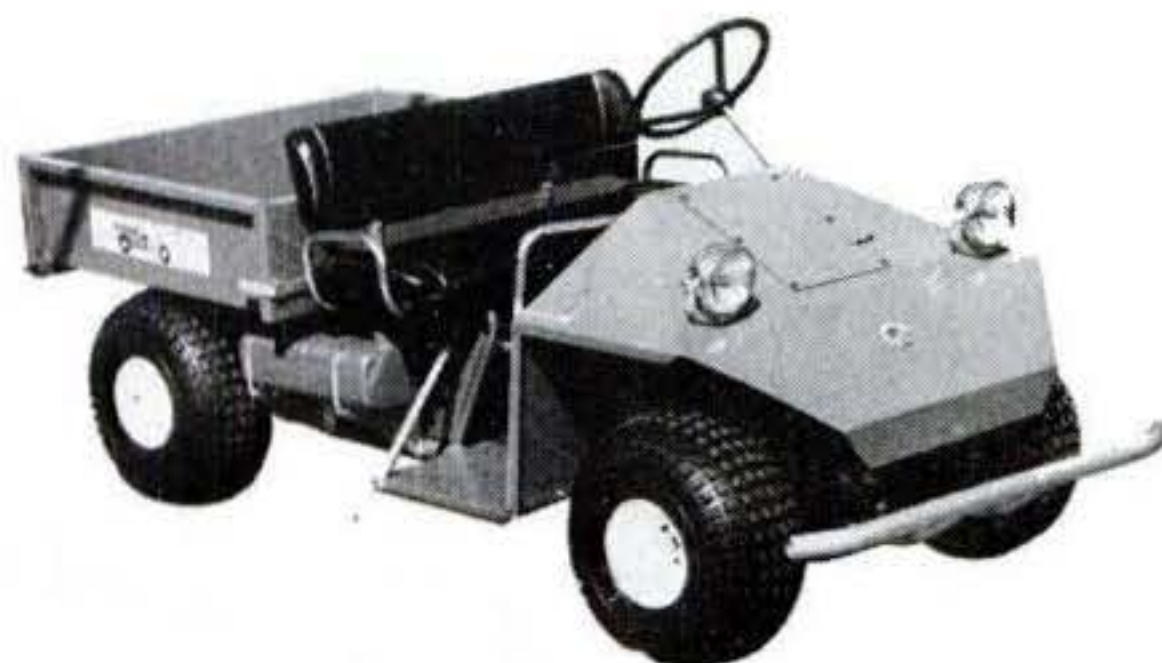


Wind power

Windgen 25, a wind turbine with 19-foot-long, downwind blades, drives a generator, alternator, pump, or compressor at the tower base. Blade pitch is computer controlled. Rated power: 25 kW or 30 hp. New Dawn Energy Concepts, Box 1017, Plainview, Tex. 79072.

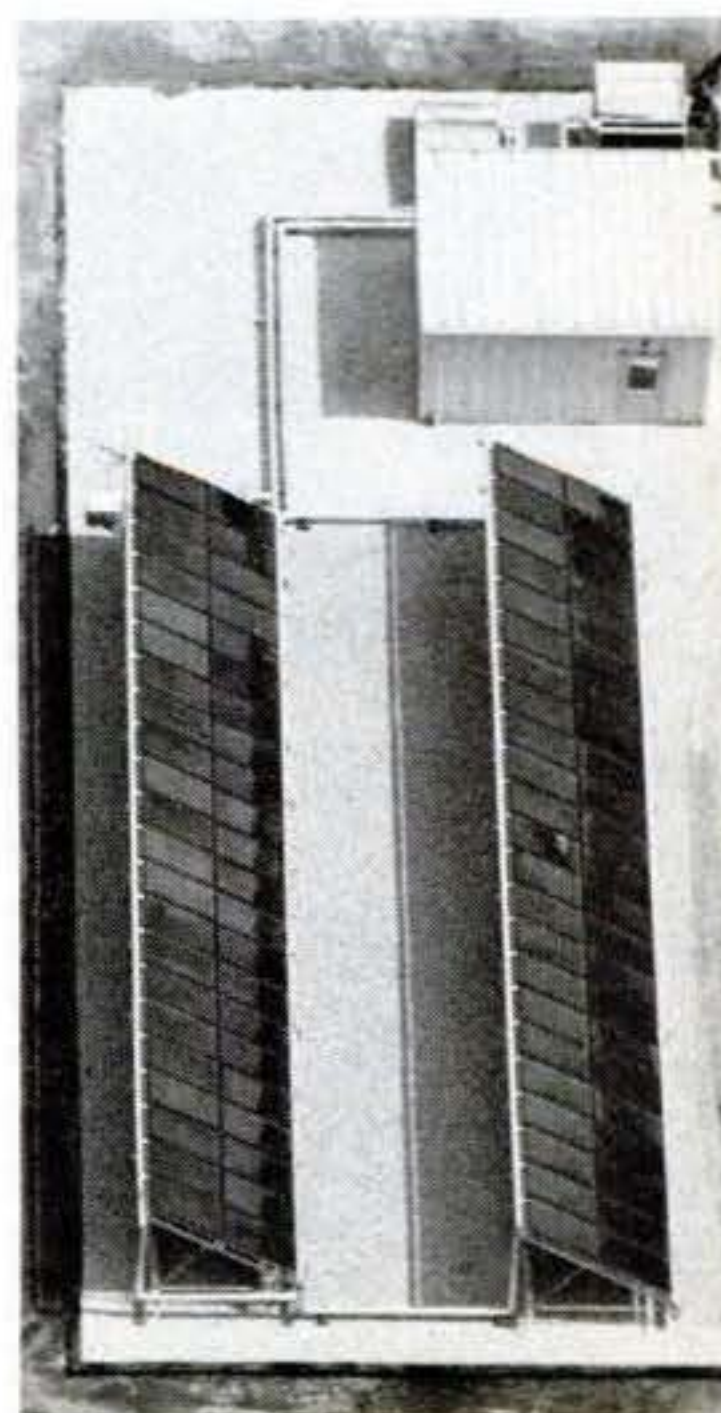
Hauler kits

Bolt this quarter-ton hauler together from a kit and you can tote 800 pounds across fields or work sites. Electric-start Mark Series haulers are available with three or four wheels, an 11- or 16-hp engine. Carl Heald Inc., Box 1148, Benton Harbor, Mich. 49022.



Heater/cooler

Solar panels heat water to drive a 15-ton absorption refrigeration machine at Carrier's Tyler, Tex., plant. The machine produces chilled water for air conditioning. The Carrier-built system is expected to cut the energy used for heating and cooling 15-20 percent.



Topless Mercedes

Three Mercedes S-class convertibles offer power options designed for fuel economy. Optional 218- and 240-hp light-alloy V8's get 21 mpg at 55 mph. A 185-hp in-line six is available, too. The folded hood stows flush with the body, and a detachable hard-top speeds conversion to a coupe.



What's New IN PHOTOGRAPHY

BY E. H. ORTNER

Flash Polaroid

Polaroid's new OneStep Plus instant camera comes with a Q-Light electronic flash. The motorized aim-and-shoot SX-70 camera uses four AA cells, has a recycle time of nine–10 sec., and won't shoot until its flash is recharged. Price: \$67.95.



Zoom 110

A built-in flash swings out to light up the scene while a seven-element, 25–42-mm f/5.6 all-glass zoom lens captures the image in Keystone's XR608 110 camera. An LED signal in the viewfinder tells you when to use the flash. Price: \$110.



Fashion 110

High style's the term for ITT's new Fashionflash 110 camera, which comes in silver or beige. It features push-pull action (pull to open and advance the film, push to close) plus built-in flash and normal and telephoto (22- and 44-mm) lenses. It's \$59.95.



Carousel projector

Move over, Kodak. Now Leitz has a projector that takes Kodak carousel trays. The U.S.-made Pradolux RT 300 features an f/2.5 90-mm lens, continuously variable two–20-sec. interval timer, electronic remote control, and a built-in cord rewind reel. Price: \$636.

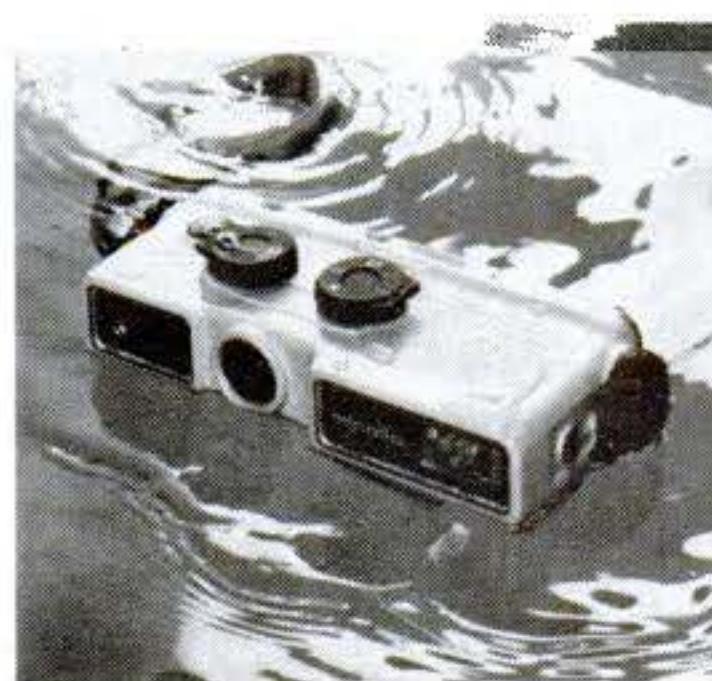


Tripod sling

Find carrying a tripod a nuisance? The Soligor Duo strap could help. It's designed to tote a camera, but a removable loop at each end tightens around your tripod's legs, turning the strap into a sling. The Duo strap sells for \$5.85.

Auto-focus super 8

Everything's automatic with the Sankyo Sound XL-320: focusing, using the VAF system [PS, July '78]; sound-level control; and exposure. The aim-and-shoot sound camera has an f/1.2 10–30-mm zoom lens, single-frame capability, and remote-control jack. It's \$550.



Floating 110

It's the world's first water-tight pocket camera, says Minolta. In fact, you can even take the Weathermatic-A down to a depth of 15 feet. It features electronic flash, three-setting exposure control ("sun," "cloud," or "flash"), a 26-mm f/3.5 four-element lens. Price: \$160.



What's New IN BOATING

BY SUSAN RENNER-SMITH



Two cats—a speedster and an inflatable

A sailboat towing a skier? Stiletto can (above right)—it's been clocked at 25 mph. The speedy craft weighs just 1100 lbs., thanks to advanced construction. The 27-ft. hulls are made of nylon-reinforced honeycomb sandwiched between layers of aircraft-quality fiberglass. The camper-cruiser version costs \$20,000 from Force Engineering, Ashton Ct., Sarasota, Fla. 33853. By contrast, the KAT 516 (above) costs \$3588, but the tough inflatable is almost impossible to capsize. New V-bows and 23-ft.-high masts improve performance, says Semperit (Field Pt. Rd., Greenwich, Conn. 06830).



Powerful auxiliary

Not for trolling only—that's what Mercury says about this new 23-amp auxiliary. The Thruster Plus produces 28 pounds of thrust, enough to maneuver larger boats into position. Extra thrust comes from a planetary reduction gear that slows the prop for greater torque.

Handy RDF

Easy-to-hold, easy-to-read Lo-Kata radio direction finder features an LCD frequency display. A night-lit compass sits atop the 3½-lb. unit. When null is found, a tone sounds and a light flashes. Price: \$699. Intl. Marine Instruments, 3 Republic Rd., N. Billerica, Mass. 01862.



Fishfinding TV

Fishfinder One's unique split screen shows the sonar scene at a given depth magnified four times. The elongated, five-in. TV screen of this first computerized sonar recorder gives a clear picture at 30, 60, or 120 ft. Price: \$1298. Aquadata, 750-C Turney Dr., Houston, Tex. 77038.



What's New IN TOOLS

BY R. L. STEPLER



Screwdrivers

Interchangeable blades let these Xcelite screwdrivers do the work of six. Stubby Two-in-One (top) converts from $\frac{3}{16}$ " slotted to #1 Phillips, costs \$3.60. Four-in-One is $7\frac{1}{2}$ " long, has $\frac{3}{16}$ " and $\frac{1}{4}$ " slotted blades and #1 and #2 Phillips. Its price: \$7.25.



Scriber

Circle Scriber attaches to most 16-foot tape measures so you can accurately scribe four-inch- to 32-foot-diameter circles. Price: about \$6. Maker: Circle R Corp., 17815 Valley Vista Blvd., Encino, Calif. 91316.



Fiber-optic driver

Screw in a dark spot? Four optical fibers run the length of this screwdriver's blade to direct light to the tip. Batteries and bulb are in the handle. From Arrowlite Tool Corp., 717 W. Robertson St., Brandon, Fla. 33511.



Hose and reel I

Unwind 50 feet of polyester fabric hose from Black & Decker's Hose & Reel. Two-ply hose is rated to 450 psi; water inflates it to $\frac{5}{8}$ " diameter. Hose & Reel measures $14\frac{3}{8}$ " by $9\frac{5}{8}$ " by $1\frac{1}{2}$ ", weighs $2\frac{1}{2}$ pounds. Price is under \$30.



Handles

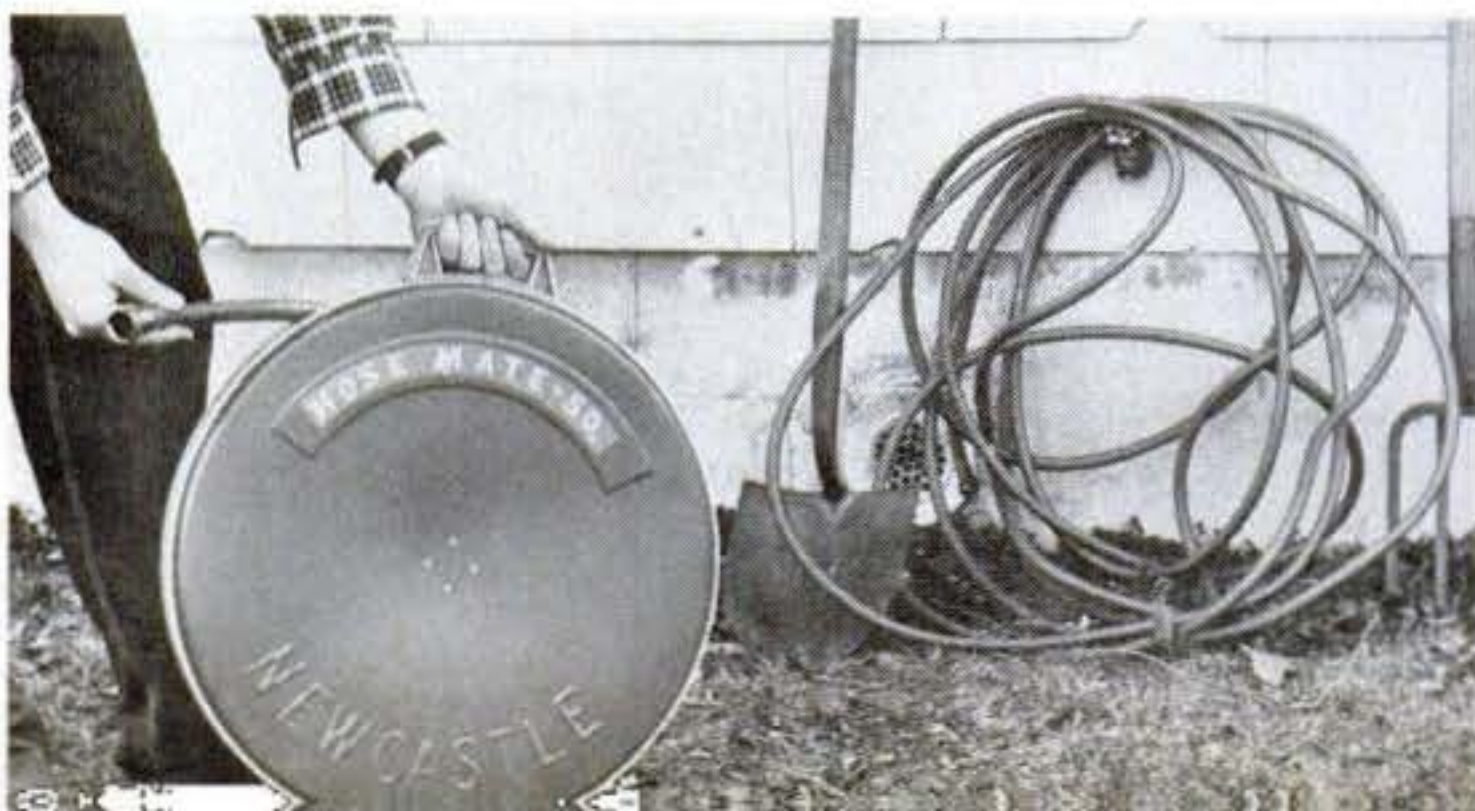
Stop stooping, says the maker of Back Preserver attachments for shovels and hoes. Model BPS-1 for shovels, spades, garden forks costs \$19.85; BPH-2 for hoes, rakes, mops costs \$14.95. From Marco Products, 1259 El Camino Real, Menlo Park, Calif. 94025.

Plastic cutter

Score thin plastics twice, thicker materials three times with this tool's tungsten carbide tip. Then snap laminates upward, other plastics downward for clean, burr-free edges, says Gripp-Ease Tool (Box 68, Lackawanna, N.Y. 14218). Price: \$6.95.

Hose and reel II

No twists or tangles with Hosemate 50, claims Newcastle Industries (Box 8026, Kentwood, Mich. 49508). Unwind up to 50 feet of standard $\frac{5}{8}$ "-dia. garden hose from the reel; to rewind, pull trigger on handle and "walk" hose back to the faucet. Price: about \$35.



What's New IN HOME IMPROVEMENT

BY R. L. STEPLER



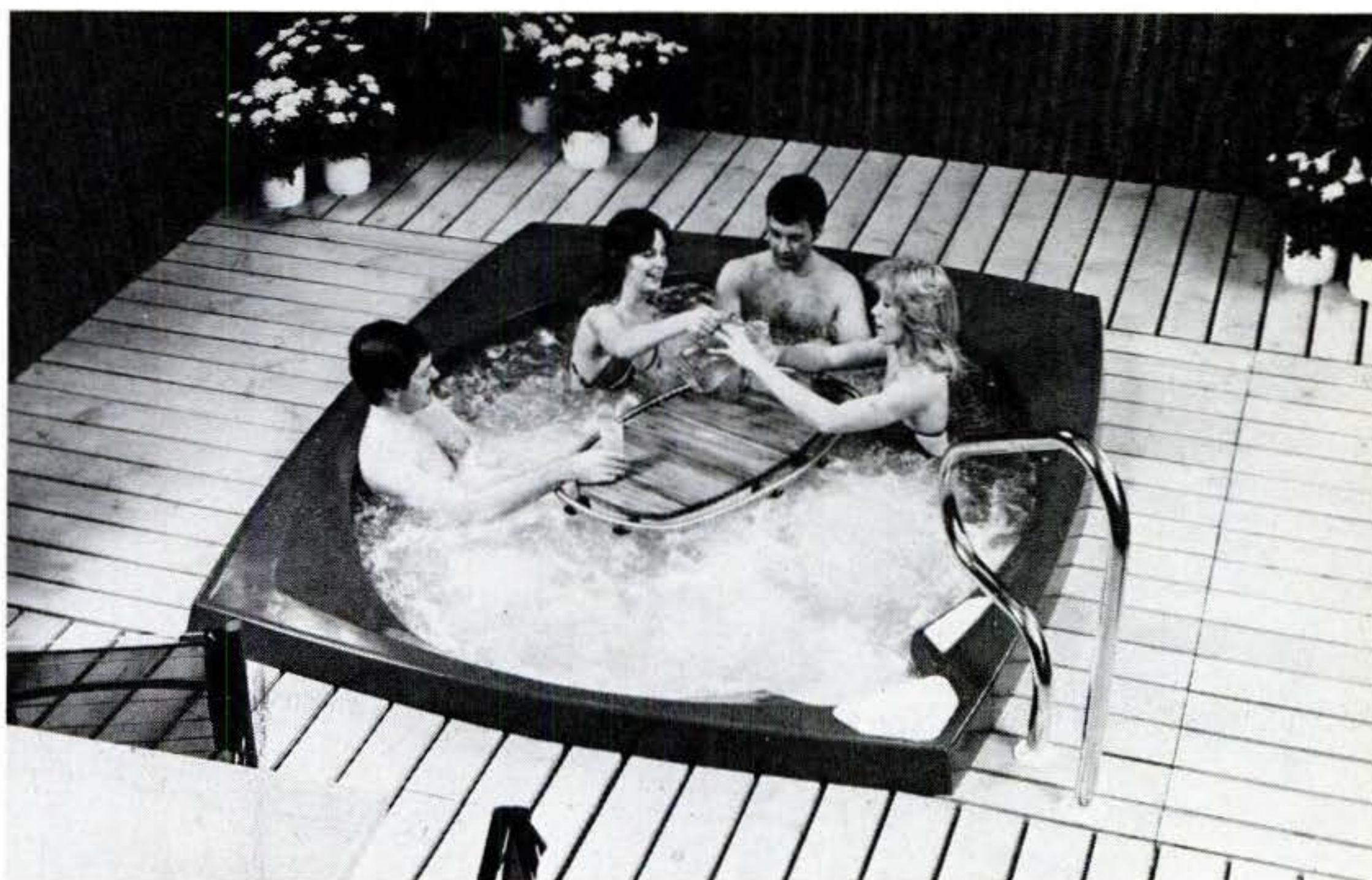
Acrylic coating

Water-based Rust-O-Crylic rust-inhibitive coating protects steel, galvanized metal, aluminum, wood, and other surfaces. Rust-Oleum says the new coatings can be applied by brush, roller, or spray, dry to the touch in 15 minutes, and clean up with soap and water.



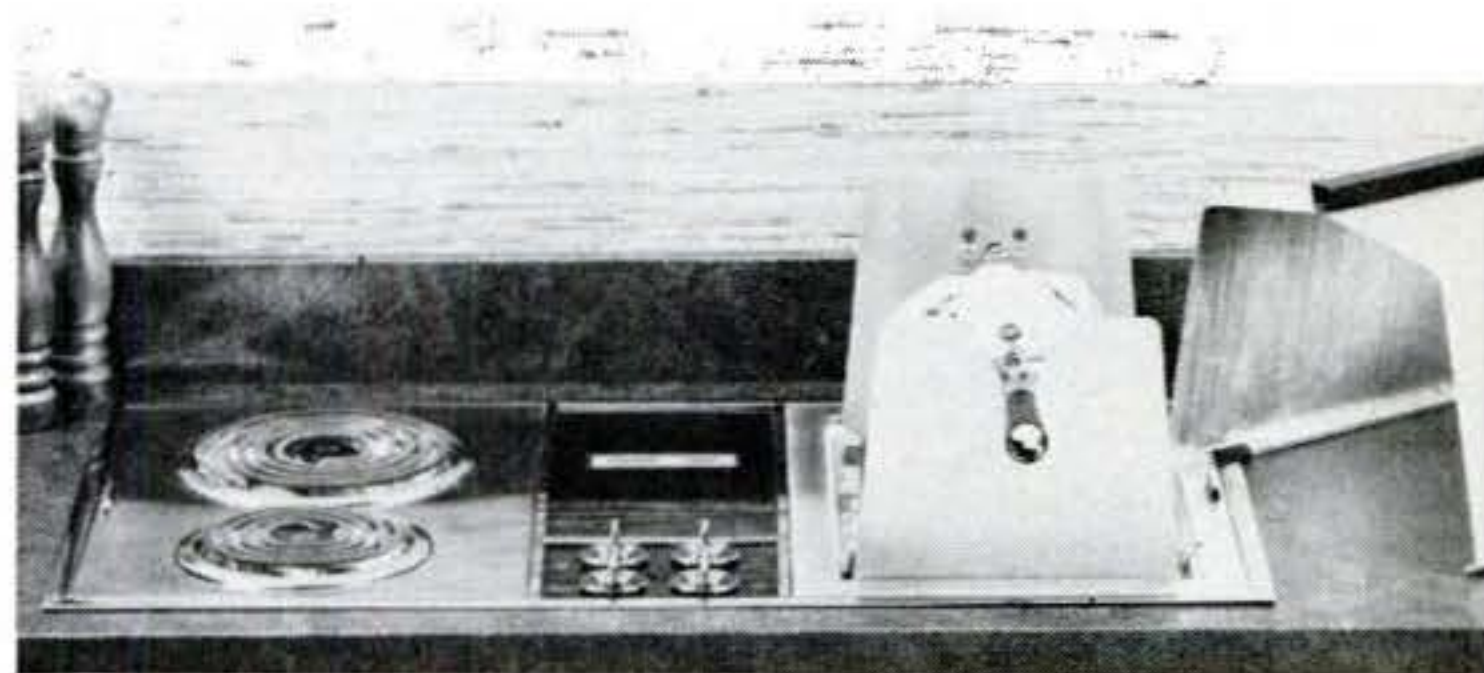
Outdoor finishes

Minwax wood finishes now can be used outdoors. Exterior Wood Finish comes in eight semitransparent colors; clear Wood Preservative doesn't alter wood's natural look. Both repel water and resist mildew and other discolorations, claims Minwax.



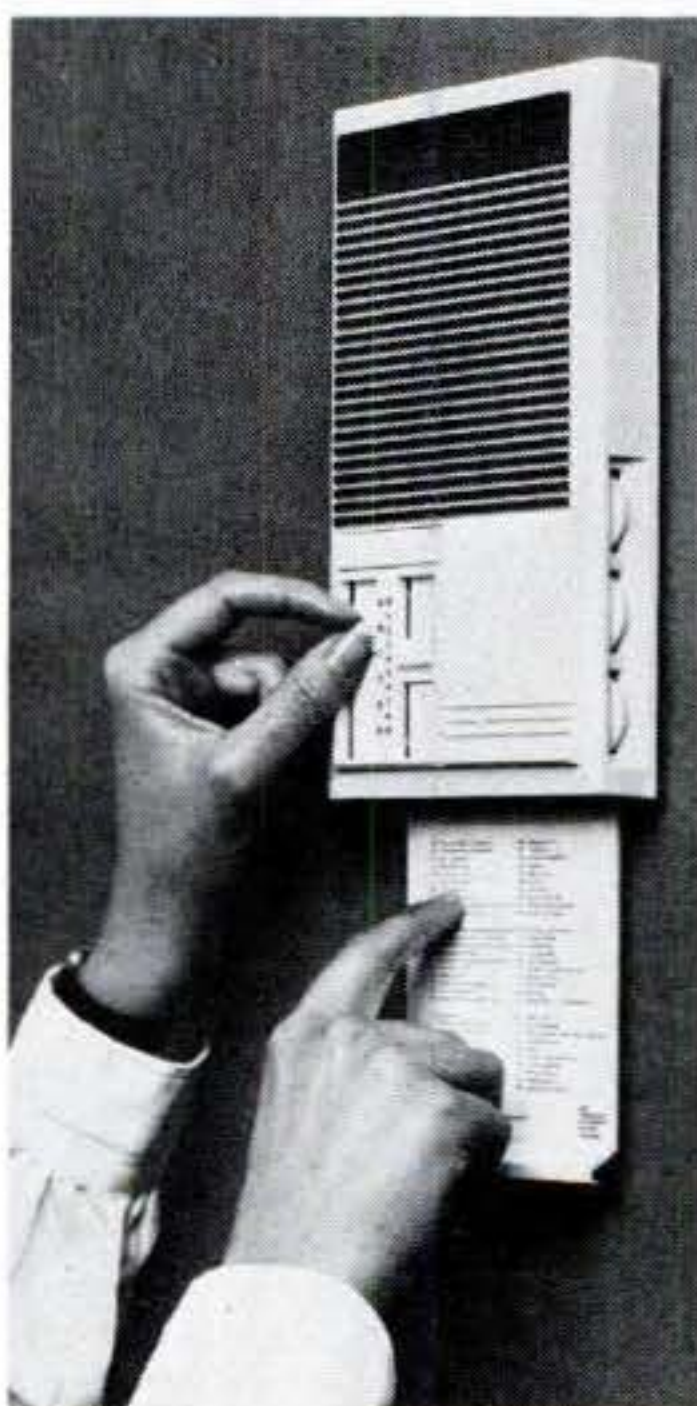
Spa

Four to six adults can soak in Super Spa's hot bubbly swirling water; a floating teak-wood table lets you enjoy refreshments, too. Kohler's spa features six directional whirlpool jets, built-in steps and optional handrail, and under-water lighting.



Door chime

Greensleeves, Dixie, and Battle Hymn of the Republic: They're among the 60 tunes GE's Orchestra door chime plays when someone rings your doorbell. The microprocessor-controlled device has a built-in index; you slide two knobs to choose the tune. Price: \$79.95.



Modular cook top

Tappan's 35-inch-wide Converta-Cook cook top provides a choice of modules: grill/griddle, open-coil electric elements (shown), one-piece ceramic top in white or black, rotisserie (shown), or hardwood cutting board. The unit can be used with overhead or downdraft venting.

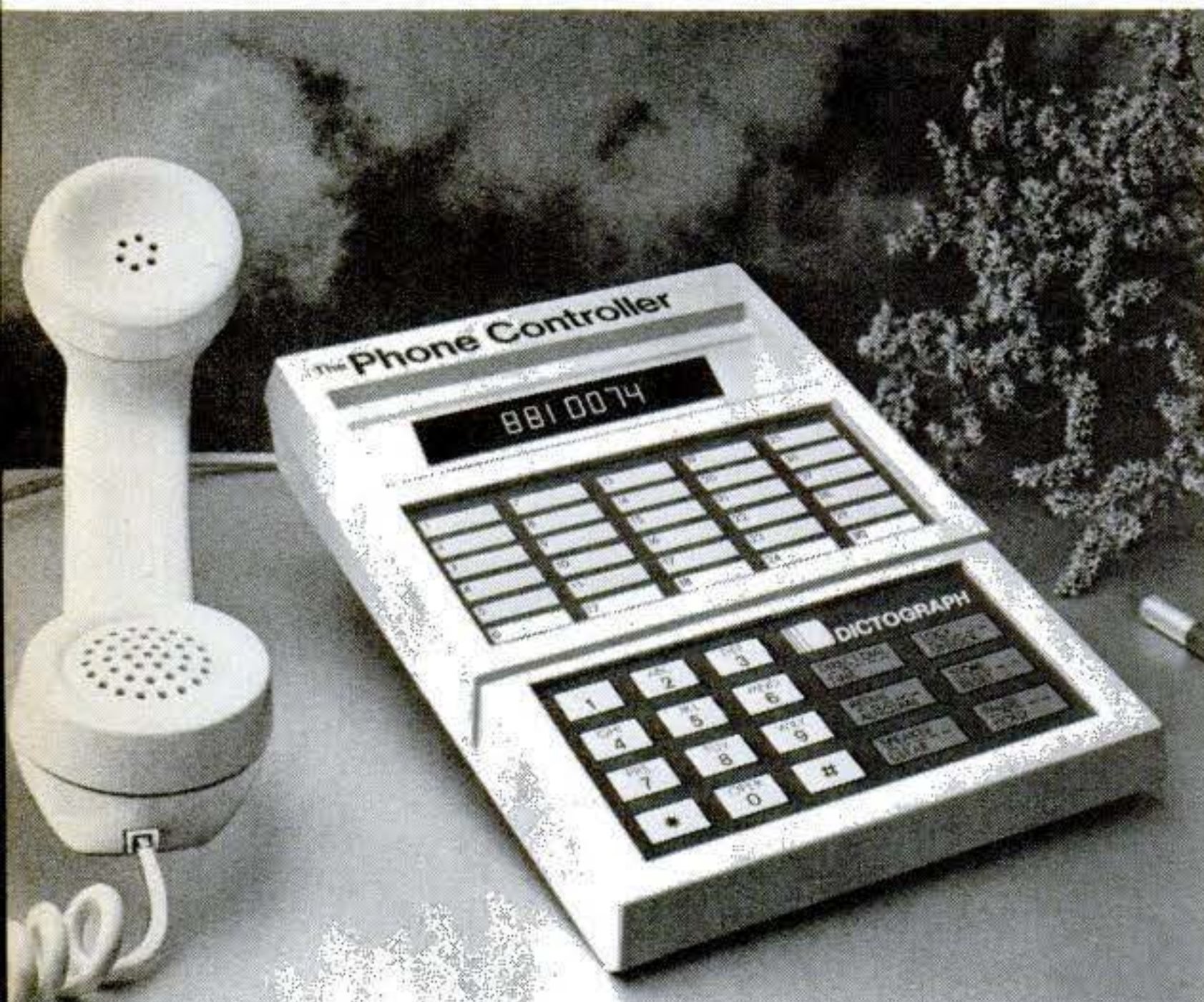


Window channels

Aluminum and stainless-steel Window Fixer Replacement Channels take the place of caulking, tape, and stick-on weatherstripping, says Quaker City Mfg. Co. (701 Chester Pike, Sharon Hill, Pa. 19079). A spring-loaded center strip seals windows tight, according to the maker.

What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Record cleaner

First, it applies a cleaning solution to the record surface. Next, it brushes the surface to loosen dirt. Then the LP is vacuumed and blow-dried. Want more from an automated record cleaner? It does both sides at once. TMA, 35 E. Hills Dr., New Canaan, Conn. 06840. \$695.

Remote car alarm

The problem with most car alarms is that you must be around to hear them. With this Mobile Alert from Radio Shack, however, you can be half a mile away—the pocket receiver beeps if your car's been broken into. Car transmitter requires a CB license. Price: \$100.

Automatic dialer

This auto dialer from Dictograph holds up to 30 numbers. What about busy signals? It automatically redials a busy or unanswered number for you every minute. Display shows number dialed, time, or elapsed time when unit is in use. The Phone Controller is \$100.

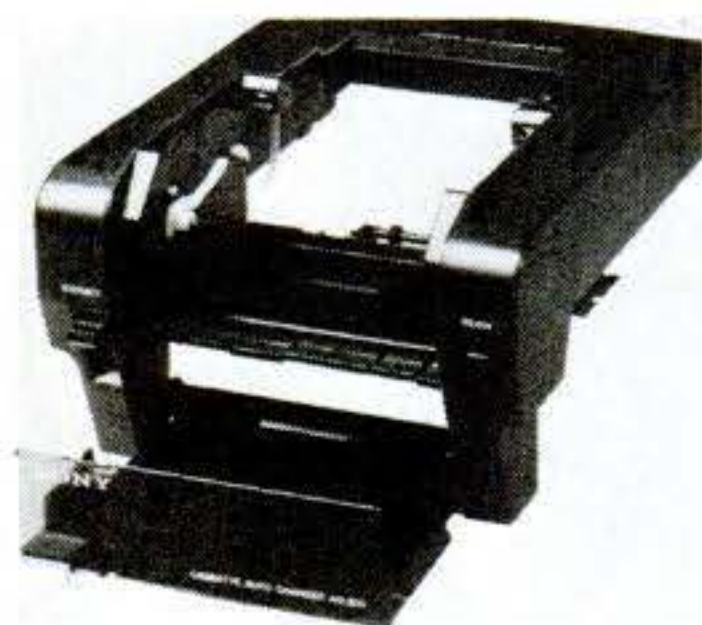
Watt checker

Keeping down the electric bill is difficult, especially for large companies. But this digital tester could help by supplying info: It shows total kWh, present kW draw, and peak kW and the time it occurred. Du Pont Energy Management Corp., 10730 Composite Dr., Dallas, Tex. \$800.



Charger

Hearing-aid batteries are double trouble for your wallet: They're expensive, and they don't last long. Now, claims The Battery Store (Box 141, Ridgefield, Conn. 06877), you can recharge them up to 500 times with this charger—for up to 10,000 hours of use. Price: \$21.45.



VCR changer

Earlier Sony Betamax video recorders were limited to just 1½ hours of record time (Beta I mode). No more. Add this changer and it automatically reloads up to three L-750 cassette tapes for three times the record/playback time. Exact changer model depends on VCR. \$125.

Head cleaner

Pop this new 3M cassette into your VCR and in less than 30 seconds, the heads will be clean. The cassette contains five minutes of abrasive cleaner to remove dirt. When heads are cleaned, a message appears on the screen telling you to turn off the VCR. About \$29.



What's New FOR YOUR CAR

BY ED JACOBS



Pickup unloader

Stretch JiffyDump's mat over the bed of your mini-pickup, and you can unload up to 1000 lbs. of evenly distributed cargo just by rolling the mat up at the tailgate. It's \$299.95 ppd. JiffyDump, Inc., 343 E. Lexington Ave. 108, El Cajon, Calif. 92020.

Rebuildable struts

You can't rebuild your original-equipment suspension struts, but these replacement units accept screw-in shock-absorber inserts. They're \$74.95 each, plus shocks, and fit 1979-80-model Capris and Mustangs. Quikcor Engineering, Inc., 6710 S.W. 111th, Beaverton, Ore. 97005.



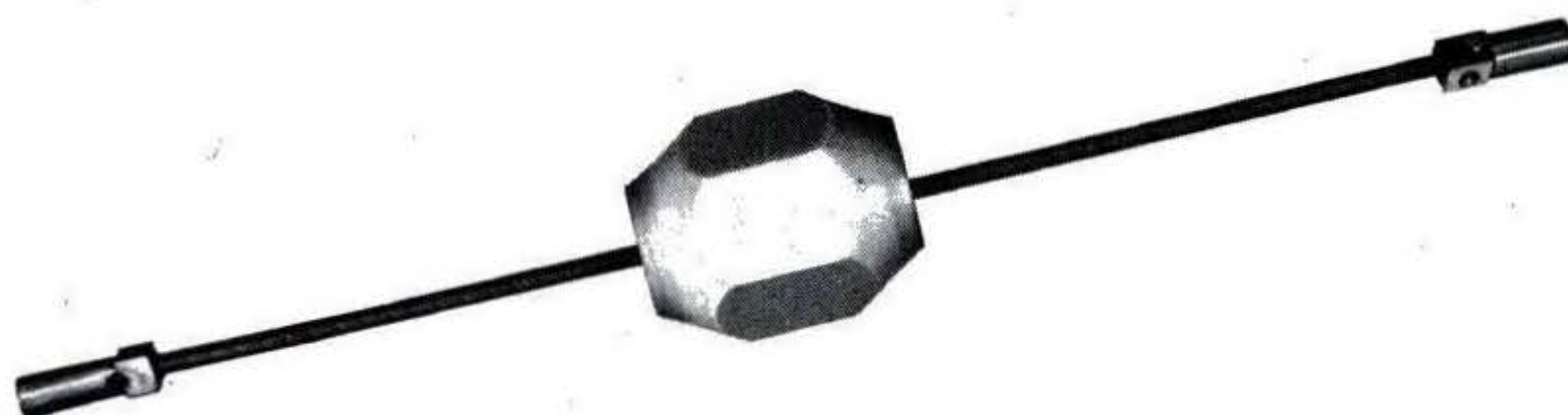
Headlight washer

Fluid jets on the wiper arms of this wiper/washer system wet the headlamp on each sweep, while the excess is recycled. Individual hydraulic motors power the wiper arms. Securon Mfg. Ltd., Springfield Rd., Hayes, Middlesex UB4 OLE, England.



GM-carb adjuster

The flexible shaft on this tool is designed for the hard-to-reach idle-mixture screws on GM carburetors. One end is a 4.5-mm hexagonal fitting, while the other is a "double D." It's from Thexton Mfg. Co., costs \$8.30, and is available at auto-parts stores.



Tidy tow

The spring-loaded spindle in the lightweight, centrally mounted container automatically takes up slack to keep this tow rope out of mud and water, and to prevent tangling under the towed car. Globelec Ltd., Grove Rd., Woking, Surrey GU21 5JB, England.

High-flex antenna

You can bend the Skinny Stick CB antenna 360 degrees without breaking, says Avanti Research and Development, Inc. (340 Stewart Ave., Addison, Ill. 60101). It's top-loaded, has a foil tuning/retuning band, and comes in black or white. Price: \$12.95.



Inside Escort and Lynx

Ford's new import fighters

By JIM DUNNE

In years past, auto makers could design new engines as easily as switching the sand mold inserted in the iron casting. Need a bigger-displacement engine? Put in a smaller insert. A smaller engine? Put in a bigger insert. That's a simple explanation, but it's essentially how it happened.

Today, auto engineers are plagued by many more problems. Foremost are emissions and fuel economy. Forget either and you're out of business. Next come engine smoothness, power, response, flexibility, size, and weight.

To design the engine for their 1981 Ford Escort/Mercury Lynx subcompact, Ford engineers used engine "mapping," a five-year-old technique that has a computer tell which design elements will do the job best. There are thousands of design variations possible, each of which can affect dozens—even hundreds—of other elements. Ideally, they should be individually explored and compared to all available data. But that mass of complex calculations has always been too hard, or impossible, for humans to do. Now, guesswork is held to a minimum, and designers get a complete picture of the engine's total potential—in terms of speed, torque, emissions control, fuel consumption, and overall performance.

Mapping results pointed to a hemispherical combustion chamber for the new 1.3- and 1.6-liter four-cylinder engines. That was a surprise, since the hemi had fallen out of favor when emissions standards made its high surface-to-volume ratio too "dirty." (Too much unburned gasoline was exhausted out the tailpipe.)

The computer also picked a second surprise—a large "squish" area—to

make the cleanest, most efficient combustion chamber possible. The squish area squeezes unburned gasoline into the center of the chamber, where it burns more completely.

What kind of results does this engine give? It's too early to tell officially, but Ford expects highway economy of well over 40 mpg. Performance won't suffer, though; prototypes have been timed at just over 11 seconds in zero-60-mph tests.

"When you compare the hemi against wedge- and prechamber-type engines," says Jack Collins, director of power-train research, "you get better emissions, octane requirements, fuel economy, and performance." Early computer comparisons of combustion-chamber types show that the hemi is 15 percent more powerful than the prechamber and 10 percent better than the wedge. In torque, the hemi is 17 percent better than the prechamber, 2.5 percent ahead of the wedge. Further, the mapped engine is more than two mpg better in fuel economy than another design that uses less-sophisticated computing techniques.

An international engine

Other engine details were chosen so Ford could build the tiny engine in different parts of the world, and so it would be most effective in a front-drive car. The aluminum cylinder head is a first for Ford, and is supplied from four different countries. The Compound Valve Hemispherical (CVH) arrangement that fits the largest-diameter valves possible into the short engine is a patented design. It's unique because the valve angles are offset from both the longitudinal and transverse center lines. This arrangement permits a single overhead cam plus central spark-plug location.

Combustion chambers are fully machined for a smoother, more uniform surface than in cast chambers. That's another new technique for Ford.

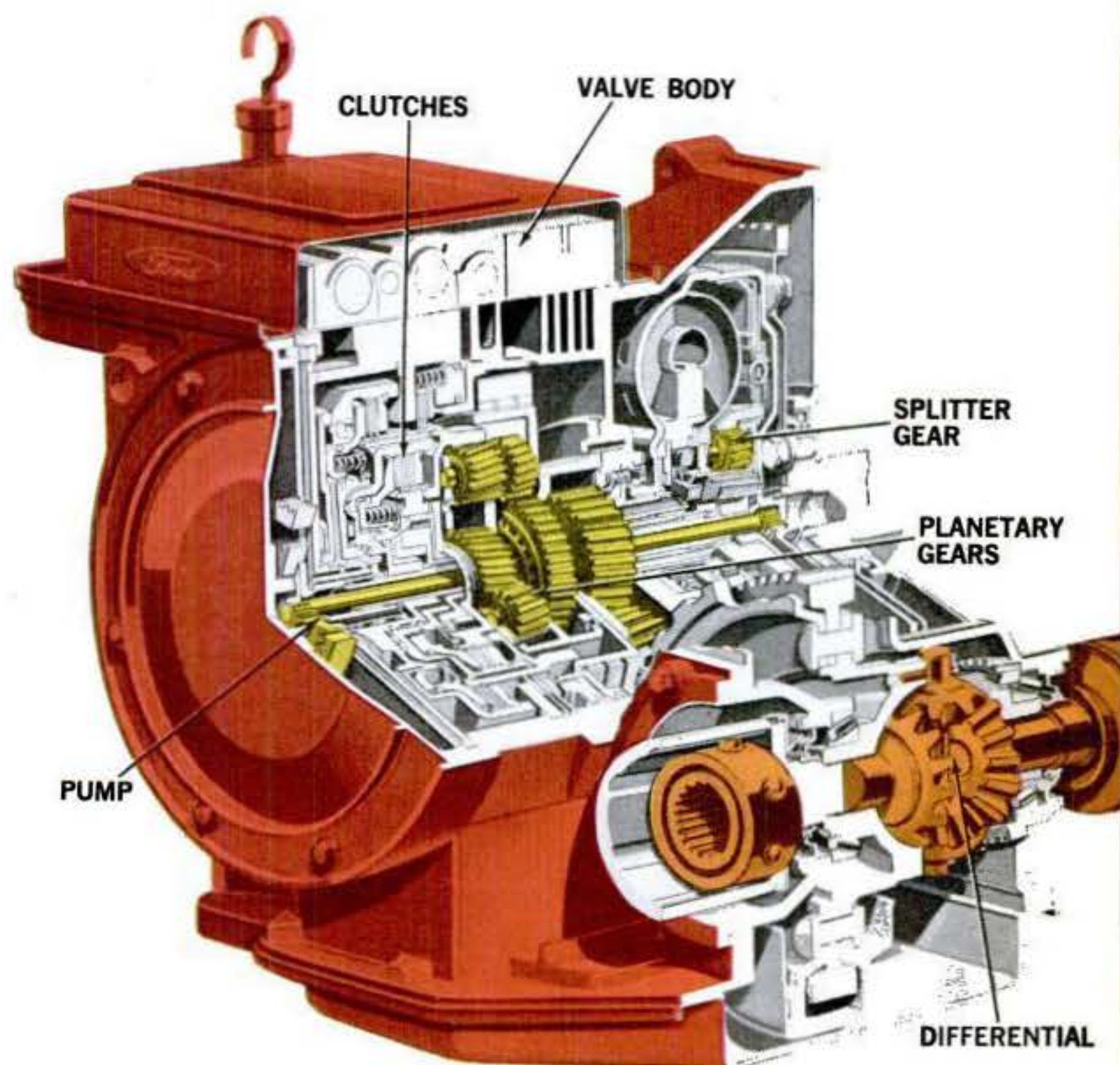
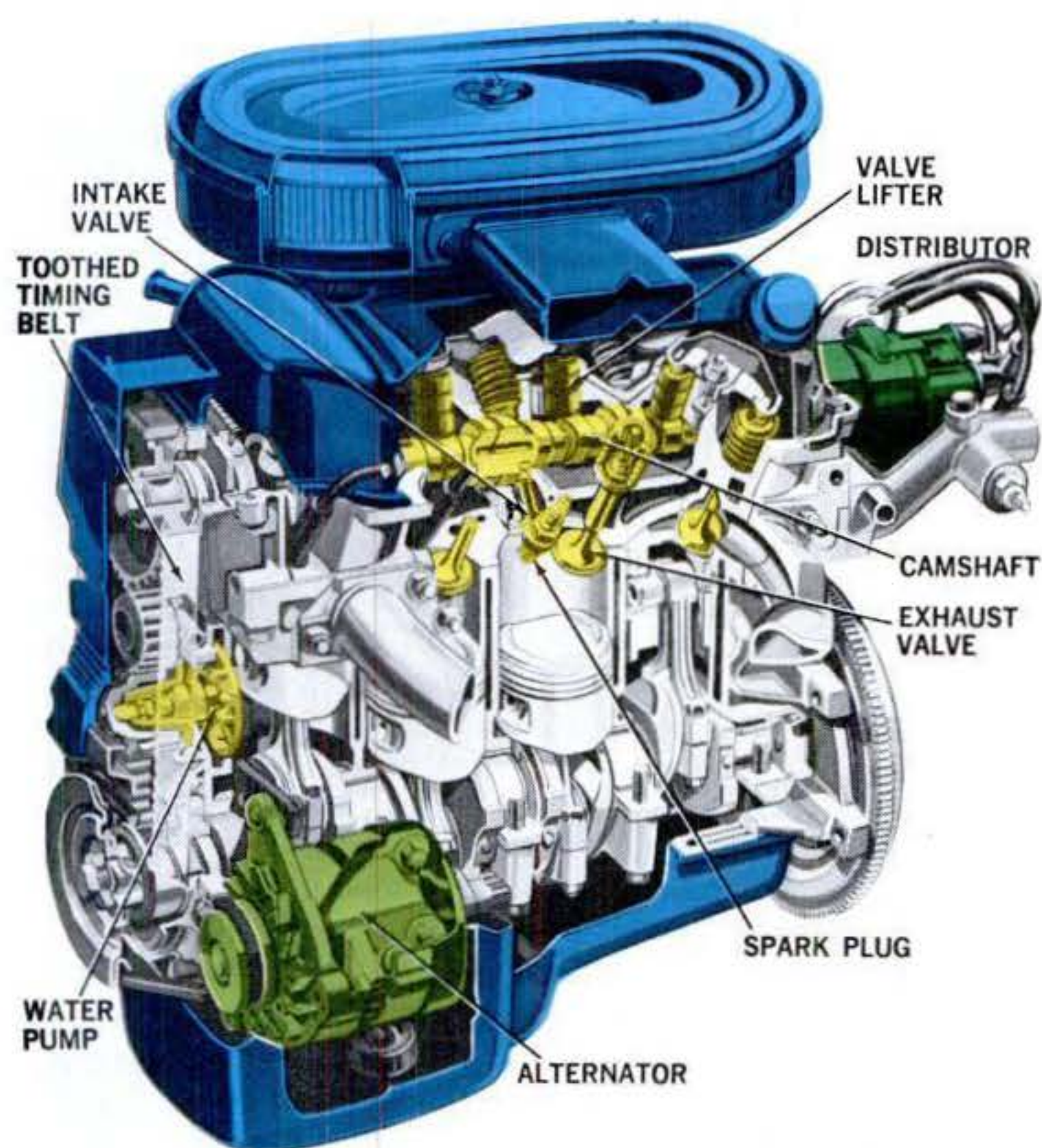
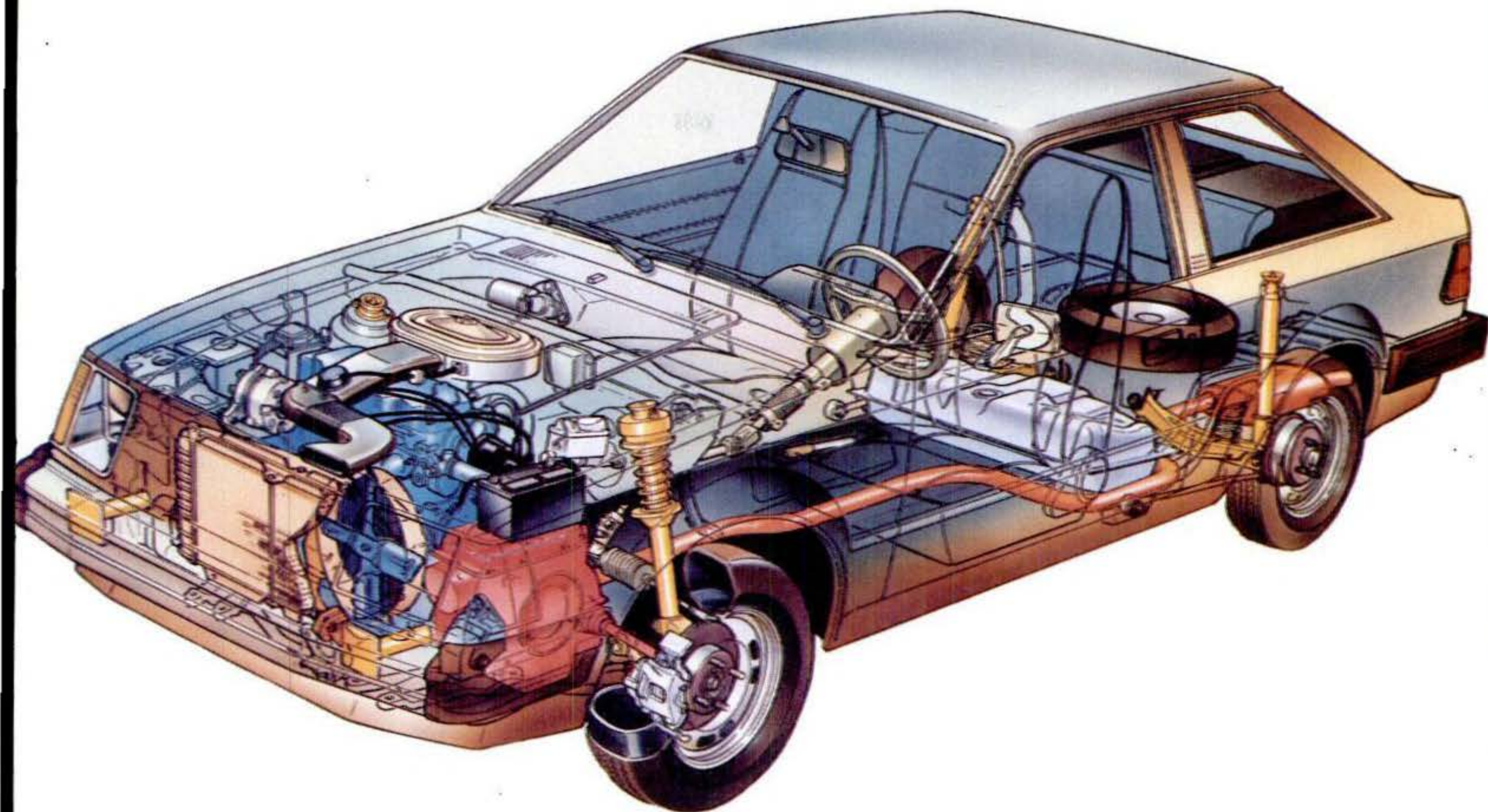
To complement the engine, Ford has all-new four-speed-manual and three-speed-automatic transaxles. The ATX automatic features compactness, ease of service, and very high efficiency. Like the AOD four-speed overdrive automatic [PS, Aug. '79], it has a split torque path. In third (high) gear, 93 percent of the power flows mechanically through the transmission, only seven percent through the hydraulic torque converter. Overall efficiency is 92 percent, compared with 82 percent for other automatics, and 94-95 for manual transmissions. Ford figures a gain of three mpg from the new transmission; two-thirds of that derives from the split-torque design.

For ease of maintenance, the transmission needs no oil changes, nor band or servo adjustments. When checking the transmission-valve body, there is no fluid loss, since the body is now atop the transmission where it can be checked from above by simply removing a cover.

Other mechanical details of the Lynx/Escort include rack-and-pinion steering and independent, coil-sprung suspension on all four wheels.

Escort and Lynx will make their debut in September, with three-door hatchback and station-wagon body styles. A two-door sporty coupe and five-door hatchback will follow several months later. These cars will replace Pinto and Bobcat as Ford's prime economy cars at the bottom of the lineup. They are Ford's first "world cars," and many of their design features will be copied in other Fords of the future.

PS



Phantom view of Escort/Lynx (top) shows major components. Engine and front drive are transversely oriented, with automatic transaxle on driver's side. Fuel tank is beneath rear seat, while spare lies in trunk well. Engine cutaway (above left) shows arrangement of valve train. Cam followers and rocker arms operate valves. Note complex shape of piston tops. Cam is driven by toothed belt, which also drives water pump. Distributor's posi-

tion at "back" of engine will actually put it on driver's side when mounted in car. American-designed ATX automatic transaxle (above right) was designed for ease of service. The valve body is mounted atop the case, unlike nearly all other automatics. Splitter gear divides transmission's torque. Flow is 62 percent mechanical and 38 percent hydraulic in second gear. In third, it's 93 percent and seven percent, respectively.

Rocket Ariane

puts Europe in satellite-launch business

Will this conventional rocket lure away some Shuttle customers?

By SUSAN RENNER-SMITH

A giant aluminum sphere hurtles through space, tracing an extravagant ellipse around Earth. The gleaming metal ball has no job. It carries no instruments. Yet it signals a new era in space: the maturation of Europe's space program.

The massive 1602-kg (3532 lbs.) sphere is a test—a dummy satellite hurled into orbit by rocket Ariane on its first successful flight last December 24. Developed by the European Space Agency, this conventional, liquid-fueled rocket promises to set Europe up in the heavy-satellite launch business. Until now, that business has been monopolized by the U.S. and the Soviet Union.

The European Space Agency (ESA), an 11-nation consortium, has participated in many NASA ventures, including the IUE orbiting telescope [PS, Sept. '78]. The two agencies will continue to cooperate on scientific ventures. But for the first time, Europe has the capacity to launch its own communications and resource satellites, rather than depending on NASA's launch schedule. And Arianespace, the commercial company formed to manage the Ariane launches, has already captured a share of the growing international satellite launch market.

Unlike the Space Shuttle, NASA's planned satellite launcher for the '80's, Ariane is based on conventional technology. The Viking engines that power its first two stages are descendants of the engines that powered

France's first Diamant rocket back in 1965. Ariane's more complex, third-stage HM-7 engines use supercooled liquid hydrogen and oxygen for fuel—as did the upper stages of NASA's Saturn V moon-rocket launcher.

ESA had gambled that Ariane's conventional design would keep down development costs—and time. Ariane blasted off from France's Space Center in French Guiana, South America, just six months behind schedule. If all goes well on this year's test flights, development costs should come in at about one billion dollars.

By contrast, the delay-plagued Shuttle, now scheduled for test flights no earlier than November, will cost over eight billion dollars.

No more dummies

Ariane's remaining test launches will orbit not dummies but working satellites.

"We call them 'launches of opportunity,'" ESA's Ian Pryke told me. "Because they're still development flights, the satellites ride for free."

Among other freebies, Ariane will launch OSCAR 9, an international ham radio satellite; APPLE, an experimental Indian communications satellite; and Marecs 1, a European maritime communications satellite.

Each satellite will be shot into a "transfer" orbit, where it dips to within 200 km (124 mi.) of Earth at perigee and swings 35,900 km (22,300 mi.) away at apogee, prior to a final boost into a circular geostationary "parking" orbit above the equator.

For such launches, Ariane's steamy equatorial home base gives it a double advantage over NASA's Kennedy Space Center in Florida. Blasting off from 5.23°N latitude, the rocket gets a greater boost from Earth's rotation. It

also can be shot into a simple, parallel orbit, instead of having to be redirected in midflight as do NASA rockets launched further north. So Ariane can carry a payload 17 percent heavier than a similar rocket blasting off from Florida.

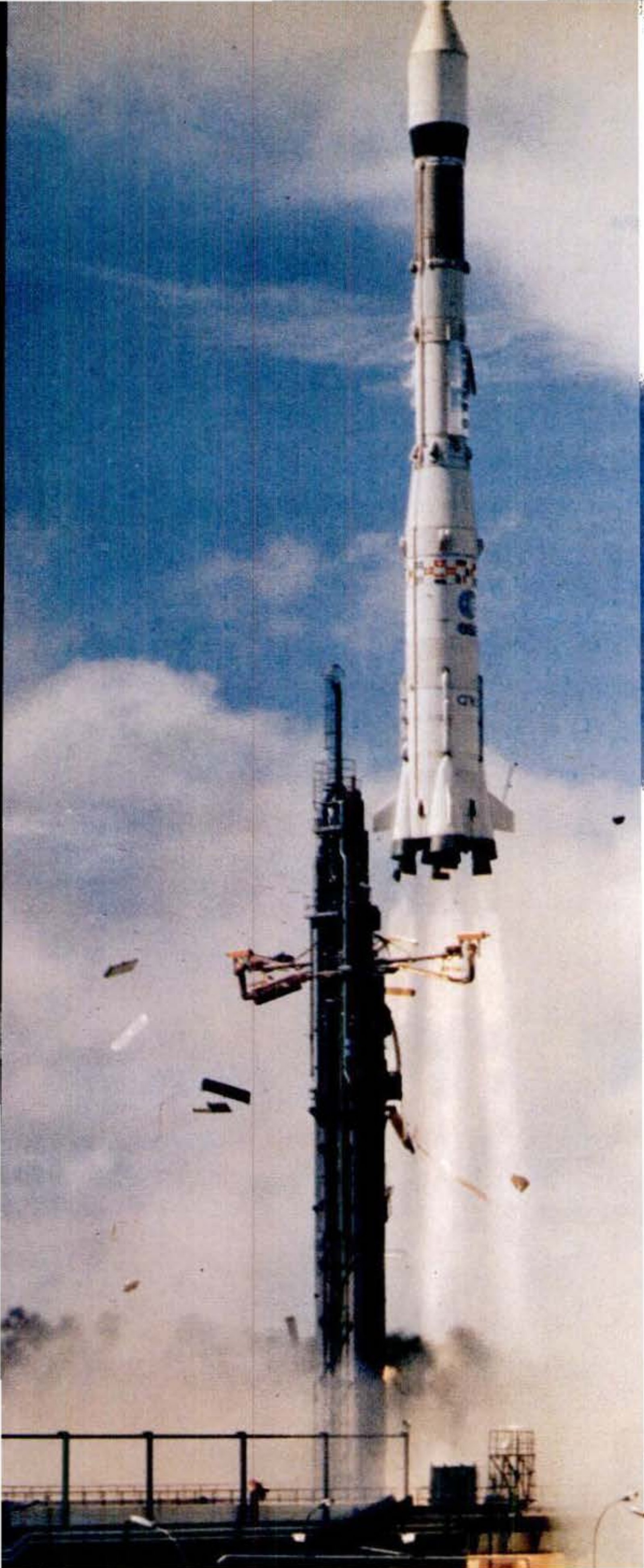
What is that similar rocket? Ariane's payload capacity falls between the Delta rocket, the workhorse NASA uses for most satellite launchings, and the more powerful Atlas-Centaur. Today's Delta 3190 can place up to 1100 kg (2425 lbs.) into transfer orbit; Ariane handles 1700 kg; the Atlas-Centaur, 1850 kg.

But the real competitor is the Shuttle. It will have practically 10 times Ariane's payload capacity (38,000 kg vs. 4800 kg) when carrying cargo into a 200-km circular orbit. But for geostationary satellites, the Shuttle has only a two-to-one advantage over Ariane. That's because Shuttle payload capacity is mostly taken up by the additional rocket booster needed to kick the satellite into higher orbit.

Neither NASA nor ESA talk competitively. "It's a seller's market," comments ESA's Pryke.

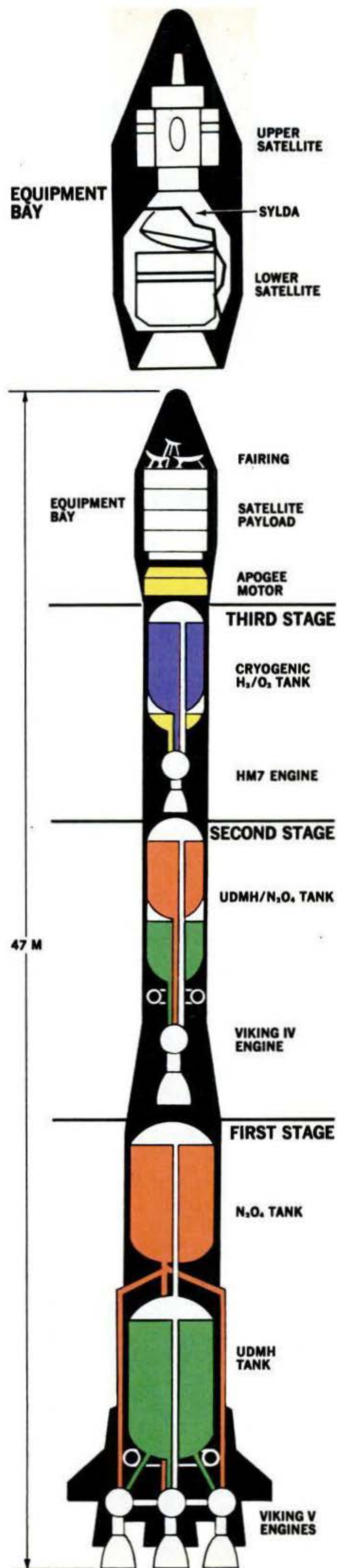
Ariane's first six operational flights (scheduled to start around May 1981) are already fully booked. And for all its delays, the Shuttle is still booked through 35 operational flights.

But competition is inevitable. Arianespace has already signed up some former NASA customers. In December 1981, Ariane will launch an Intelsat V international telecommunications satellite. Intelsat has taken an option on still another launch slot. Ariane may even nibble away at NASA's home market. AT&T and two other U.S. firms have already paid \$100,000 to reserve space on a future Ariane. P 5



Seconds after blast-off (above), Ariane's first-stage Viking engines accelerate the rocket to 1.87 km/sec. (6135.2 ft./sec.). Velocity reaches 9.76 km/sec. by the time the third stage drops off about 10 minutes later. Viking fuel UDMH (unsymmetrical dimethyl hydrazine) burns spontaneously when mixed with nitrogen tetroxide. With the special SYLDA container (top right), Ariane can launch two Delta-class satellites. The light (160 kg) but strong carbon-fiber container supports the

weight of an upper satellite while protecting the lower one it encloses. By 1983, an upgraded Ariane will be able to inject a 2000-kg payload into geostationary transfer orbit. Boosting Viking combustion-chamber pressure from 703.2 psi to 941.2 psi and stretching the cryogenic fuel tank from 800 kg to 10,000 kg will give the added power. Adding strap-on, solid boosters will enable it to lift a hefty, 2420-kg payload into transfer orbit. The Space Shuttle will have roughly twice that capacity.



Stove-centered house

designed for efficient wood heating

The look is dramatic, but the system is simple—and the house is prebuilt

By **EVAN POWELL**

DRAWING BY GENE THOMPSON

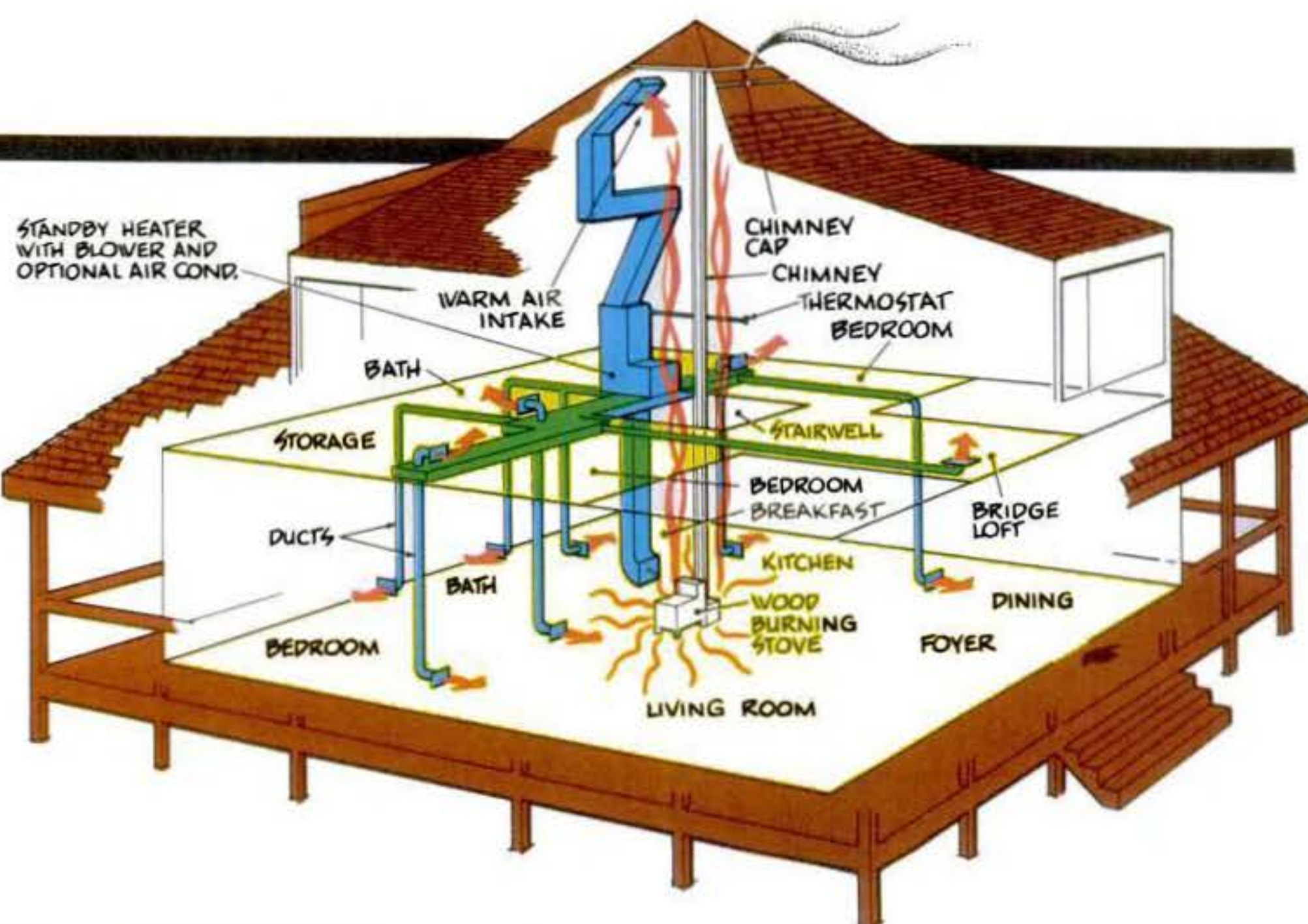
On a cold, rainy day in February, I arrived in Gainesville, Ga., to check out the new Støvehaus. This innovative house, designed by John Odegaard, vice-president of Mayhill Homes, is one of the most functional I've seen.

Instead of simply installing a wood stove in his new house, Odegaard in essence built his house *around* the stove. And this is no exotic research project—it's available now as one of Mayhill's factory-assembled homes.

The Støvehaus uses basic heat-distribution theory. Warm air from a centrally placed stove rises to a lofty, peaked ceiling. This acts as a plenum, collecting and channeling the air to an intake near the peak. A blower then distributes it via a housewide duct system.

The simple system works. When I entered the Støvehaus last February, a fire had been burning in its small stove for only an hour, and the blower hadn't yet kicked on. But the house was comfortable. Checks in various rooms did show temperature variations, so we started the blower manually. An hour later, there were no large temperature differentials, and rooms far from the stove were warming up nicely.

Now that the Støvehaus has proven itself in winter weather, Mayhill has put the model on its regular production schedule. For more information, write Mayhill Homes, Box 1778, Gainesville, Ga. 30503.



Wide-open floor plan on first level (above) lets stove warm nearby seating area directly, as well as heat house via ducts. De-

signer put stove in central entry hall (below) for efficiency—and to discourage furniture clusters close to the stove.





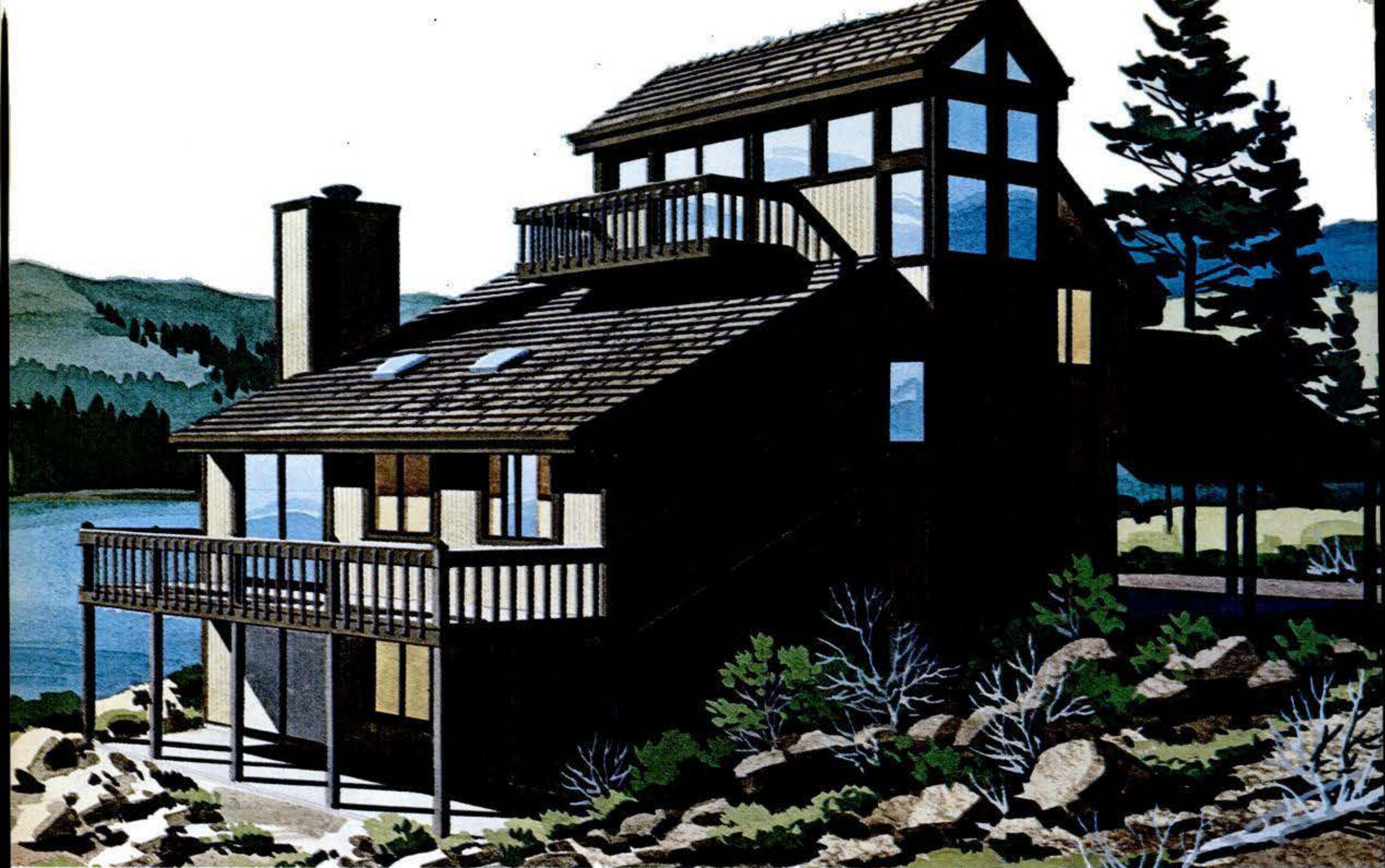
Photos copyright 1980 by E. Allen McGee, Atlanta



Veranda-encircled Stovehaus (top) has a cozy, rustic look. But modern second-story balconies and unique integral chimney cap at the tip of the peaked roof adapt the house to contemporary setting. This pyramid-shaped roof is more than decorative. It funnels warm air that rises through a dramatic open stairwell (lower left) into a ceiling air intake (visible above, left of the insulated stovepipe). The clever air-flow design allows waste heat from lights and appliances to be channeled upward along with heat



from the small Fischer stove. A larger stove was originally installed, but provided too much heat for the 2400-sq.-ft. house. The stairway opens (lower right) into the loft room that bridges the entry (see diagram, facing page). Thermostat at left of door controls blower that distributes air through ducts. If temperature drops below comfort level, a standby gas furnace kicks on. The factory-built Stovehaus is "panelized": It comes with preassembled wall sections in panels, and precut floor and roof.



PS leisure-home plan

Studio penthouse

adds a fourth story

By AL LEES

The vertical thrust of this house is so dynamic that you might be fooled into thinking it requires a larger lot than the one you plan to build on. Actually, this structure is erected on a foundation of modest size; since it's built *up* rather than *out*, it fits neatly on a site with a narrow frontage.

The scheme shrewdly clusters two stories of rooms opposite a stairway bay, stacks these atop an on-grade (or partially excavated) ground floor, and tops them with a spectacular glass perch—a lofty solarium with its own sun deck cantilevered over the main roof.

Although the actual floor space of this penthouse is only 10½ by 12 ft., the fact that the room is glazed from floor to eaves on three walls—including the top level of the stair bay—gives it unusual spaciousness. What a studio for a painter, photographer, or potter! Many of your guests will beg to sleep up there.

Nor are the main living areas of this

house (developed by Ralph Rittenour for Home Building Plan Service, in cooperation with Western Wood Products Assn.) without their own drama. The skylight-pierced ceiling of the living room soars to a two-story height under which is tucked a central balcony at the upper level. You can stand at this open railing and survey the floor below and the large deck beyond that runs the full length of living room and kitchen. (For alfresco dining, the kitchen window becomes a handy pass-through.)

Behind the master bedroom on this first floor is a double carport, the open gable of which also shelters the entry. Note on the plan at right that the location of the carport is indicated, though our space was too tight to include its outline. The 54-ft. dimension shown to the left of the plan, however, is an overall measure, including carport.

The downstairs bathroom is accessible to first-floor activities, yet functions as a master bath at night.

Upstairs are two more bedrooms flanking a shared bath that can be

compartmented for dual use. The under-roof area over the kitchen provides an active storage room with an access door to dead storage beyond, under the eaves—ideal for seasonal items such as Christmas gear.

At grade level is a daylight basement with ideal space for indoor recreation, as well as a big workshop or another bedroom and bath.

It's all in the book

This is the eighth year of our Leisure-Home Plan series, which was born from the success of the unique retreat we commissioned, constructed, and introduced in POPULAR SCIENCE's legendary 100th Anniversary issue [May '72]—the Lockbox. In recent years we've received an accelerating surge of requests for a collection of these houses, and for an updated reprint of the original Lockbox articles. So it's with pleasure I can announce that the PS Book Division has (in final stages of production) a book titled *Leisure Homes* that gathers together all the best designs from this series, plus all the step-by-step construction articles in the Lockbox series. As a bonus, the book includes complete plans for building the Lockbox and lists all sources for the many innovative materials showcased in that house.

For a review of the book and information on how to order a copy, see next month's "Shop Talk." P 9

Tilting trike

—a car that really leans into turns

A tiny three-wheel car that leans into turns like a motorcycle could be an ideal economy runabout for city driving. That's the belief of British designer Dr. Edmund Jephcott, a lecturer at Sussex University. A mere 30 inches wide, the little "trike" he's invented can snake past lines of stalled traffic; its 66-inch wheelbase makes it almost as easy to park as a bicycle. Its crafty tilt feature enables it to weave safely through snarl-ups or make sharp turns at speed without risking a spill. Unlike two-wheelers, the car is stable at a crawl and in crosswinds, while the body gives riders weather and crash protection.

Jephcott's trike has the driven wheels and engine on a rear subframe. A longitudinal pivot at the front of this frame supports the jointed chassis, which includes two tandem seats and a scooter-type steering assembly. The driver controls banking with a pair of pedals linked to the rear frame.

"It comes naturally," says Jephcott. "The foot pressure is a direct exten-

sion of the instinctive human sense of balance. There is a lateral shift in the center of gravity, allowing faster safe cornering speeds than a conventional four-wheeler."

Jephcott's first experimental model has a 75-cc, four-hp scooter engine with centrifugal clutch and expanding-pulley belt transmission. Two fist-grip levers on the handlebars operate front and rear brakes, leaving the feet free for the tilt pedals. Another hand control locks the body upright on its pivot for stability when parking and climbing in and out. For testing, the weight of a two-seat body is simulated by a metal frame and roof panel.

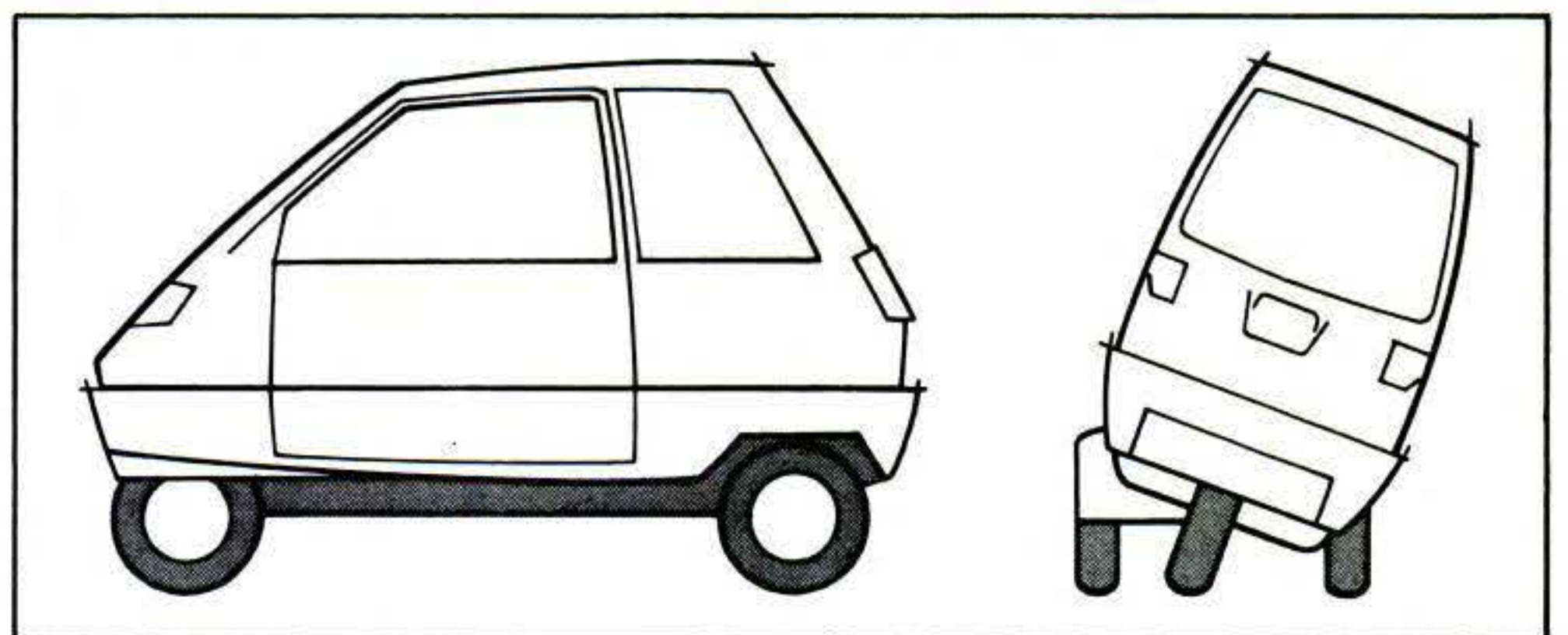
Several British manufacturers are showing an interest in Jephcott's design. In production, the car would have a 400-cc, two-hp engine. He figures the low weight and low wind drag would give it brisk acceleration, 50-mph cruising speed, and fuel consumption of 100 mpg. An 81-inch-long fiberglass body would have a single curbside door for access to both seats: one front, one rear.—David Scott



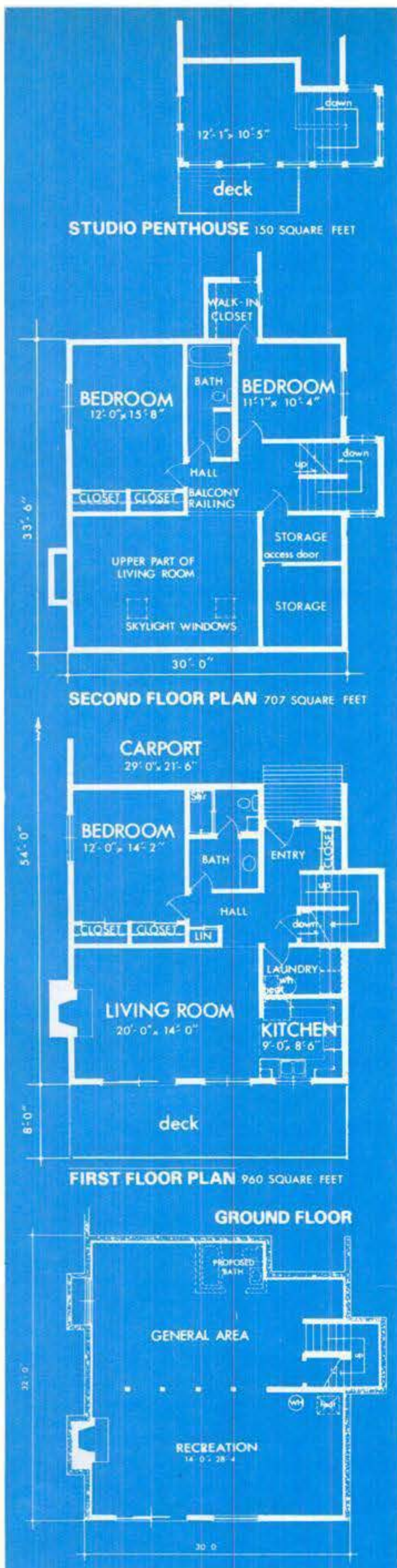
Edmund Jephcott's trike has twist-grip throttle at handlebars. Center of gravity



shifts on turns, allowing safe cornering, since rear wheels stay flat on road.

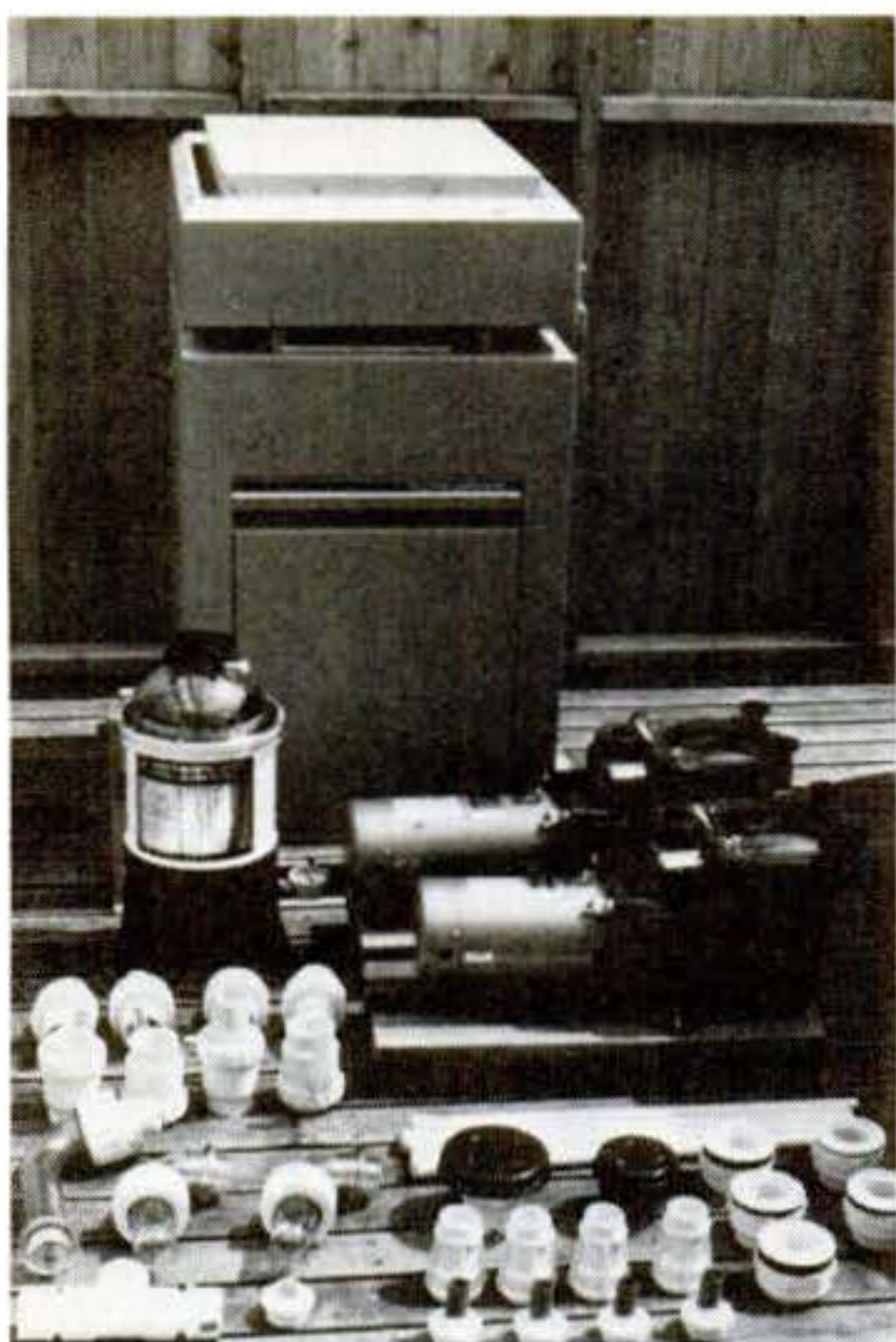


Proposed fiberglass body would have single door for access to front and rear seats.



How to order your plans

One set of professionally drawn plans for the Studio Penthouse is \$100; four sets—for building, financing, and permits—are \$140. Plans can be reversed for \$20; building-materials list is \$15. Send orders and queries to Home Building Plan Service, 2235 N.E. Sandy Blvd., Portland, Ore. 97232, or call toll-free (800) 547-5570 for plan 936-1 (936-1A without basement).



Choose your route to an **install- yourself hot tub**



Whether you buy a kit or create your own, putting the system together is a weekend project

By AL LEES

PHOTOS AT LEFT BY LOIS PERSCHETZ,
BELOW AND RIGHT BY CALIFORNIA COOPERAGE

Nobody ever called me a swinger—and lived—but I yearn to host my first hot-tub party. The research I've done on this latest California phenomenon to sweep the country has confirmed a personal conviction: The sybaritic gloss put on hot tubs by careless re-

Fire Island tub party is hosted by Perschetz couple, far left, who gathered all components for their own kit (top photo). Tub is actually a six-foot-diameter cedar reservoir for commercial rooftops. For step-by-step instructions, turn page.

GATHER YOUR OWN COMPONENTS

HAVE A COMPLETE KIT DELIVERED



Even easier route is to buy complete kit from packager such as California Cooperage. Truck will unload knocked-down redwood tub (easily assembled as in photo above), gas or electric heater, pump, filter, timer, and four-jet massage system.

porting may have given the trend an extra, momentary surge of popularity; but in the long run it's done tubs a disservice.

Basically, hot-tubbing with family or friends isn't all that different from socializing around a swimming pool. It's just cozier—and much less costly.

It's also, I've found, more fun, and much more relaxing. A backyard pool—especially ringed with active kids—can quickly become a bore and/or a trial. A frothing tub of 104-degree water, on the other hand, is a *mandate* to relax. Under an open sky, with a bottle of chilled white wine within reach, a soak is especially delightful—whether you enjoy it alone, with The Loved One, or with a small, congenial group.

Communal bathing has a long tradition in most other cultures but our own: in ancient Rome, Japan, in the Scandinavian sauna, even at the elegant spas of Edwardian England. It's long seemed that only in Puritan America was the baring of a bit of flesh such a major hang-up or charge. But the hot tub is now well on its way to changing all that.

Perhaps more importantly for POPULAR SCIENCE readers: While installing an in-ground swimming pool is not a do-it-yourself project, assembling a hot tub assuredly is—at least right up to those final electrical and plumbing hookups, where your warranties (and local codes) call for a licensed pro.

And whether you choose to shop for your own components (as Lois and Art

Perschetz propose on the following pages) or purchase a commercial kit (sample sources listed at end of text), you'll find it an easy and rewarding weekend project that will enrich both the value of your home and your family lifestyle.

You can, of course, install a hot tub indoors—in the interests of privacy and heat conservation. But, unless you provide good ventilation, you'll be courting condensation problems. By far the most popular siting is on the back deck or patio—or out under the trees at a country home. You can buy—or make from Styrofoam—an insulating cover that also keeps out debris.

Heat-up time is quick—and, if you have a favorite hour for tubbing, you can set the heater to turn on in time. Some hot-tubbers start the day with an invigorating hydro-massage. Others prefer to unwind with a soak and a shot after a day at work. Still others find tubbing an ideal prelude to a good night's sleep.

The couple assembling the tub on their patio (below left) will need to add a short access stair for climbing over the four-ft. side of the tub (benches inside make stepping down into the water easy). The Perschetz couple sank their tub through an existing deck, which provides easy entry. They simply cut a hole large enough and set their tub on the ground below. Still other access ideas are shown in sample sketches on page 99.

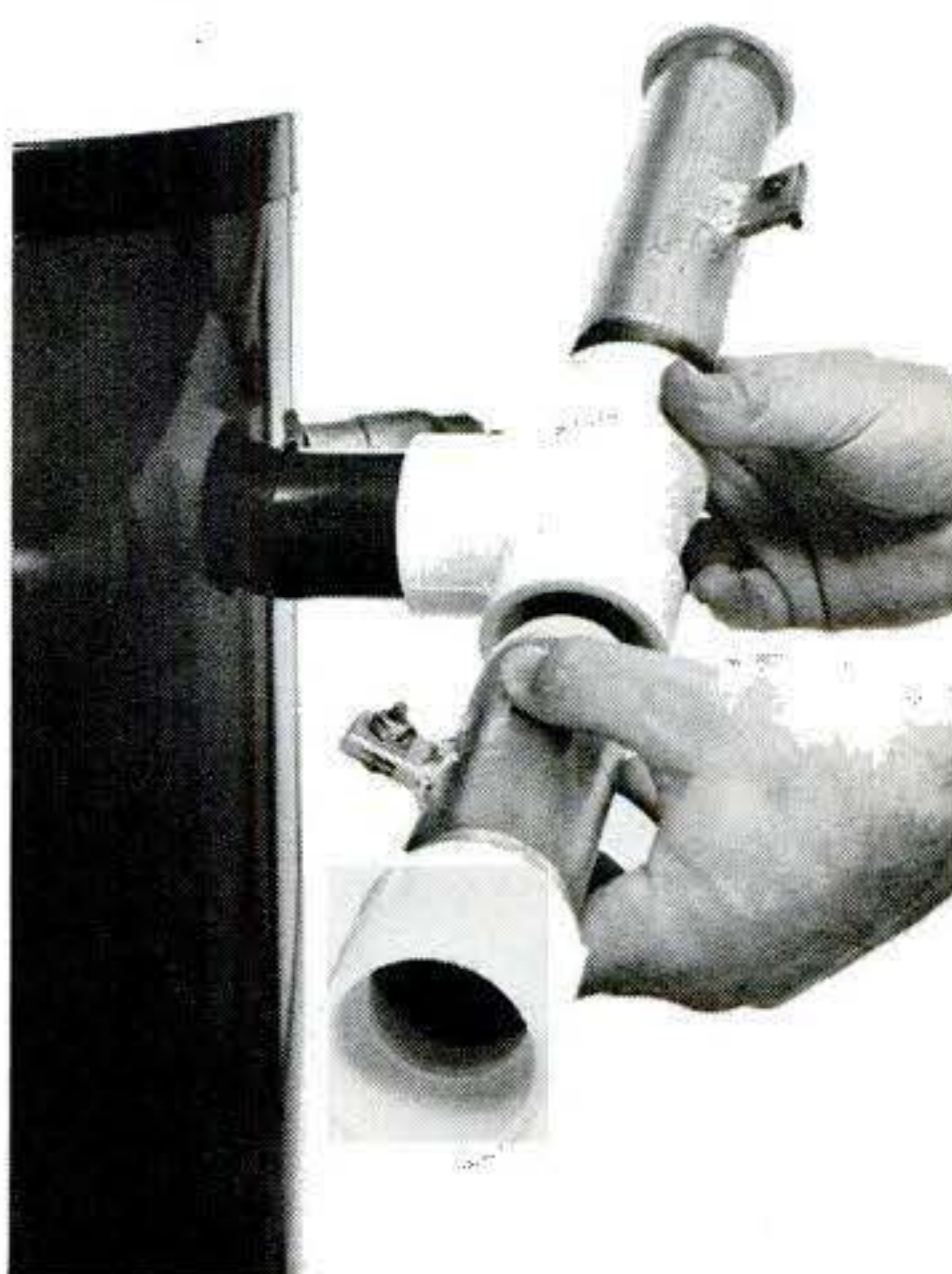
For how-to tips, turn page



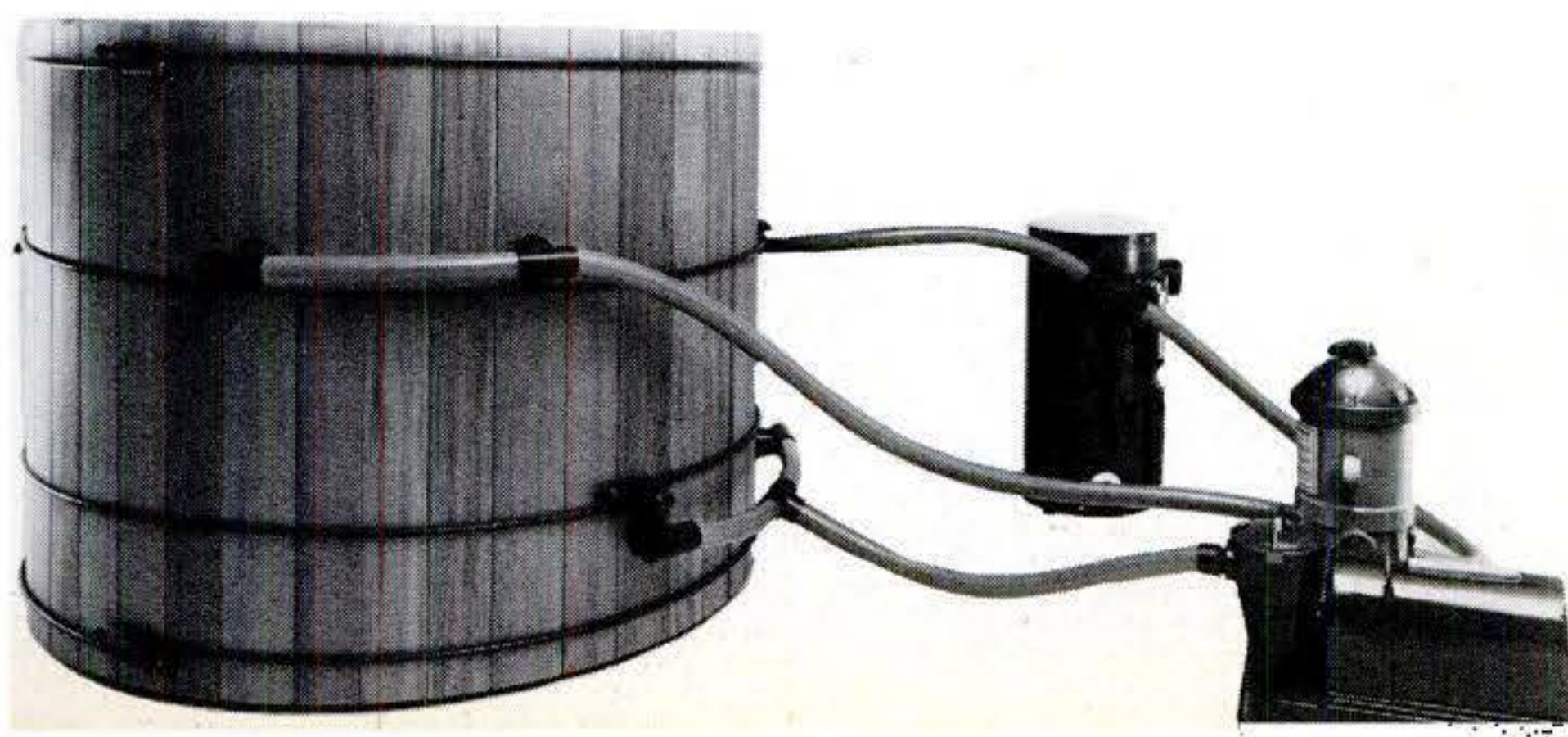
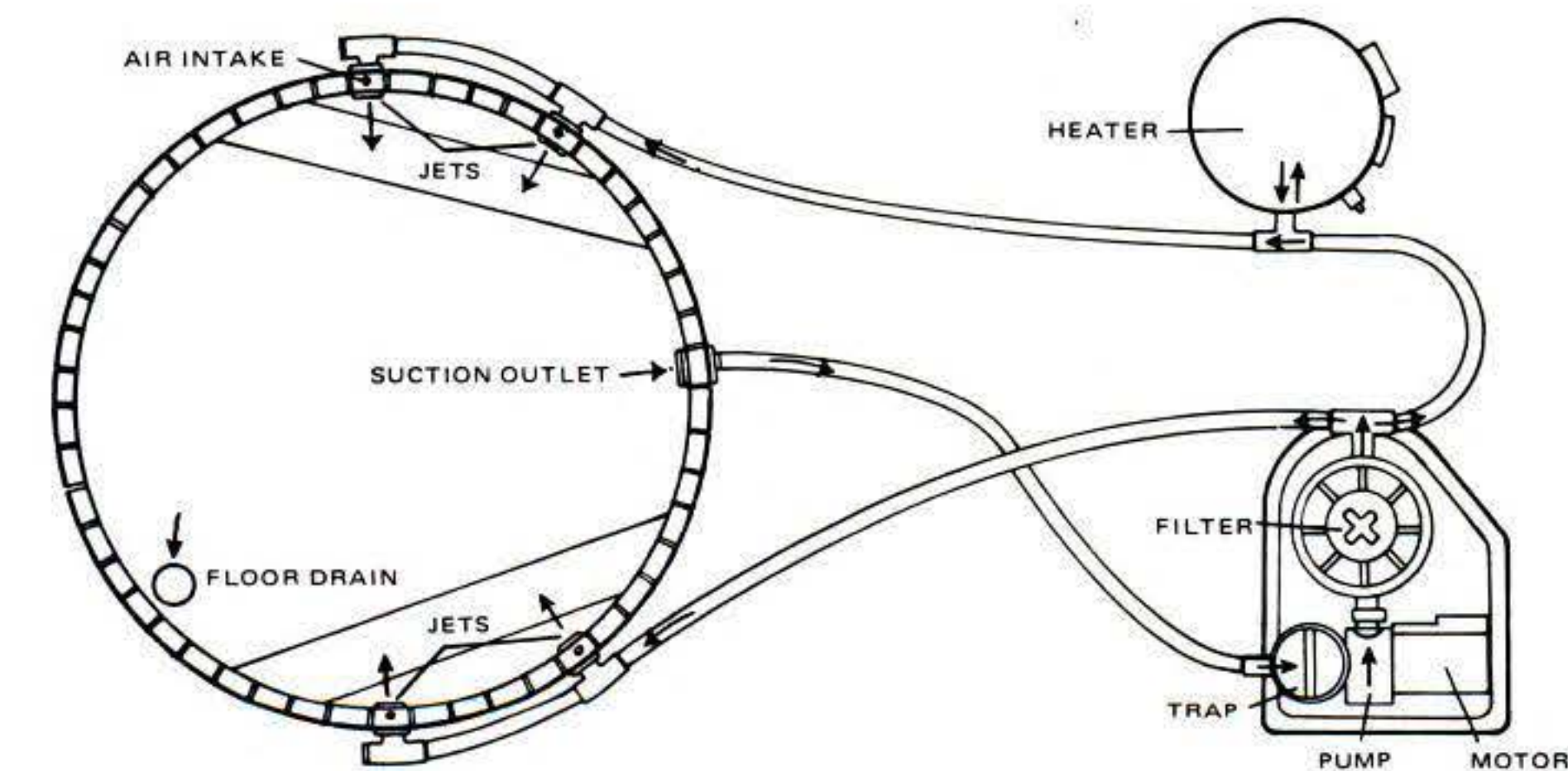
Outlet fitting with suction grate is inserted through tub wall from inside. Gasket on outside secures it.



Tee-fitting with Teflon-taped threads screws into base of filter unit in the California Cooperage system (see diagram).



Electric heater takes bypass tee with current collectors screwed into either end; flexible adapters cap these ends, above. Plan view and photo, left, show typical seat, jet, and drain arrangement. Higher seat and jets (30 in. high) would be at top of plan. Outlet can be yoked pair (as in photo) or single, direct to pump's trap.



Assembling a system from your own components

By LOIS and ART PERSCHETZ
PHOTOS BY THE AUTHORS



Predrilled, doweled floorboards are assembled across chime joists set on concrete footing. Tap with rubber mallet.



First staves are erected (check vertical with level), and croze (rabbet) near bottom end is tapped onto edge of floor.



When tension is consistent and floor is fully seated in croze, drill openings for inlet jets and outlet with expansion bit.



After inlet and outlet fittings are installed, connect with PVC pipe. It's still a do-it-yourself job up to this point.



Call in a pro for final connections to heater. With plastic pipe, we needed heat-sink connectors shown: 1½-in. copper pipe.

As the hot-tub craze has spread cross-country from California, so has the number of dealers who'll sell you complete systems—either assembled at your site or shipped in kit form.

But we found that by carefully shopping for components from standard sources, such as swimming-pool suppliers, we were able to accumulate our own package at about half the cost of a comparable installation from a hot-tub dealer. The price, last year, of our six-foot-diameter wooden tub with all the necessary support equipment came to just about \$1500. Prices we were quoted on commercial kits for a tub of the same size ranged from \$2700 (delivered) to nearly \$3500 (installed).

The components we had to assemble were actually very few: a leakproof container, a heater capable of bringing the water temperature up to 104 degrees, a filter, and a pump to circulate the water and operate the hydro-

massage jets, plus the fittings.

After a couple of weeks of research, we put together this package:

- Six-foot-diameter, five-foot-high tank in cedar.
- 250,000-Btu Teledyne Laars propane heater.
- 50-sq.-ft. cartridge filter from Hayward.

Time (min.) to raise temperature 10°

Gallons	Gas/oil heater (Btu/hr. input × 1000)			Electric heater (kW input)		
	80	150	250	6	12	24
300	25	13	8	73	36	18
400	33	18	11	97	48	24
500	42	22	13	122	61	30
600	50	26	16	146	73	36
700	58	31	19	170	85	42
800	66	35	21	194	97	48
900	75	40	24	219	109	54
1000	83	44	27	243	121	60

Example: To raise temperature of 800-gallon tub 70° to 100° would take 105 minutes using a 150,000 Btu gas heater, 63 minutes using a 250,000 Btu gas heater, or 291 minutes using a 12-kW electric heater. 100° is generally considered minimum. Up to 104° the tub's like a conventional bath; you can loll for an hour. At 106° you can stay in for only 15 or 20 minutes at a time, hopping out for air or hose cooling between soaks. 108°–110° temperatures are risky. (Data from Teledyne Laars.)

- ½-hp Hayward Super Pump for filter and heater.

- 1.5-hp Hayward Super Pump for hydrotherapy system.

- Miscellaneous Hayward fittings and PVC pipes.

- Pacific Spa anti-vortex outlet.

All our choices had to be readily available, easily shipped, and *dura-*

Common tub sizes and weights

Depth × diameter (ft.)	Capacity* (gallons)	Water wt.** (lbs.)
3×4	210	1750
4×4	300	2450
4×5	470	3925
4×6	675	5625
4×7	930	7750
4×8	1200	10,000
5×5	620	5175
5×6	890	7425
5×7	1210	10,075

*When tub is filled for use (3" to 6" from rim)
**Does not include weight of tub, support equipment, or bathers. All figures approximate.



Subsequent staves are also tapped half-way onto floor's edge, snugged together, and held in shape with wide masking

tape. Tight joints will be assured by steel hoops that clutch staves tightly against swelling of the wood when tub is filled.

ble, because we were shopping in New York City (not exactly swimming-pool country) and shipping to our weekend home on Fire Island, a car-less spot where everything must go by ferry and servicing could be a headache.

We found our tub through a water-tank manufacturer, who pointed out that his products are so sturdy they sit unattended, though in constant use, for 50 years or so on rooftops of city buildings. All of our support equipment came from a neighborhood swimming-pool supply house.

Two rules of thumb in selecting a heater: Electric is cheaper in initial cost, but gas is cheaper to run; and a larger heater, though more expensive, will heat the water quicker and thus run a shorter time.

We selected the 250,000-Btu Tele-dyne Laars propane heater because it would be able to heat our 890-gal. tub in an hour and a half, based on average summer temperatures (see table). Additionally, service would be available through the gas supplier at our somewhat remote location.

The heater, which comes in models for outdoor (our choice) or indoor/outdoor use, has provisions to reverse the heat exchanger for the right or left side to facilitate almost any installation. As our heater was to be placed on

a wooden deck, the owner's manual noted it would need a base. We bypassed the manufacturer's optional base for combustible floors and substituted a concrete-block base.

Because we had determined we would be using Schedule 40 PVC pipe, this heater offered the advantage of a universal flange mount that would permit the use of any of three different types of metal pipes required as a heat sink with PVC.

In picking a filter, we considered all three possibilities—sand, diatoma-

ceous earth, and cartridge—each of which comes in a range of prices depending on size and quality. We rejected the first two for different reasons: While the advantage of sand is that it will filter the highest number of gallons per minute, its disadvantage is that cleaning the filter requires backwashing with large quantities of water.

And while an earth filter requires only minimal backwashing to clean, it needs additions of diatomaceous earth from time to time—a rather complicated and cumbersome process.

The cartridge filter is definitely the simplest to maintain: It needs cleaning when the pressure gauge indicates the cartridge is clogged. Then it's simple to remove and wash off with a hose before returning it to the filter. We selected a 25-sq.-ft. cartridge filter from Hayward as the proper size for our gallonage.

We considered a great number of pump-filter combinations before deciding on a two-pump system—a small pump to provide water for the filter and heater and a larger one to power the hydrotherapy nozzles—rather than a single pump for both functions. Our reasoning: With the water having to be filtered each day (via automatic timer), it would be more economical in

[Continued on page 111]

Precautions for hot-tub use

As hot tubs proliferate (nearly 90,000 spa and tub units sold last year), so will problems caused by careless usage.

The Consumer Product Safety Commission warns that hot-tub drownings have resulted from excessive water temperatures and alcohol use, which caused drowsiness. If you're drinking, never soak alone or raise the water above 105°. Pregnant women shouldn't soak in water above 100°. Don't soak if taking medications that induce drowsiness.

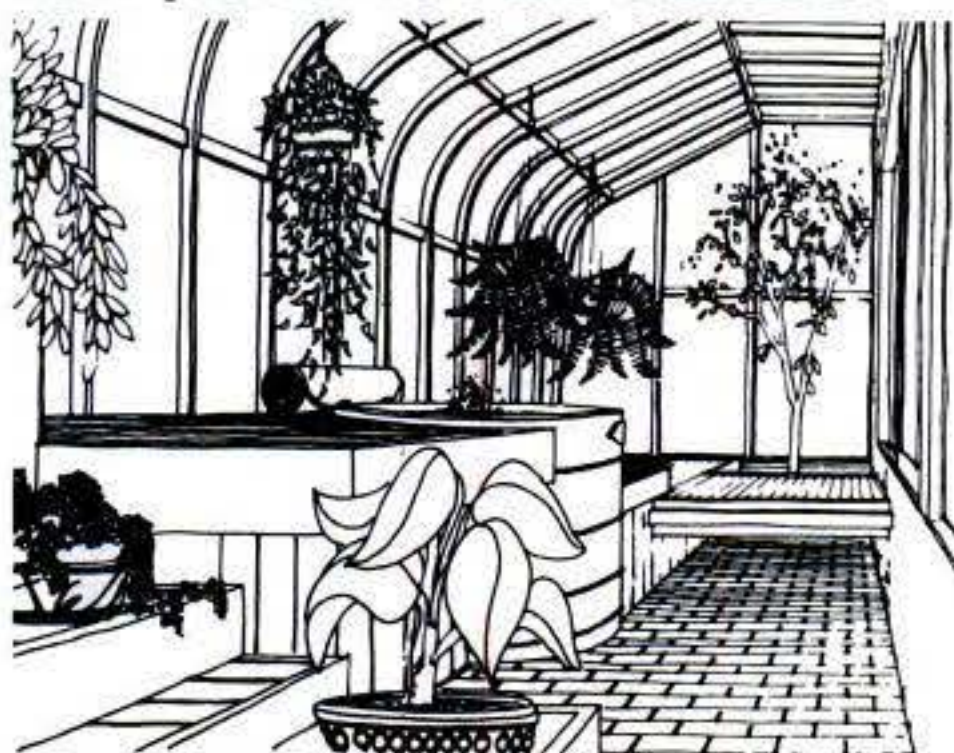
Water treatment is also important. High temperatures induce perspiration, speed the loss of chlorine and growth of bacteria. Two people in a 400-gallon tub are equivalent to 200 people in a 20-by-40-ft. pool. For leisure-home installations, in-

vest in an automatic chlorinator to prevent algae growth while you're gone.

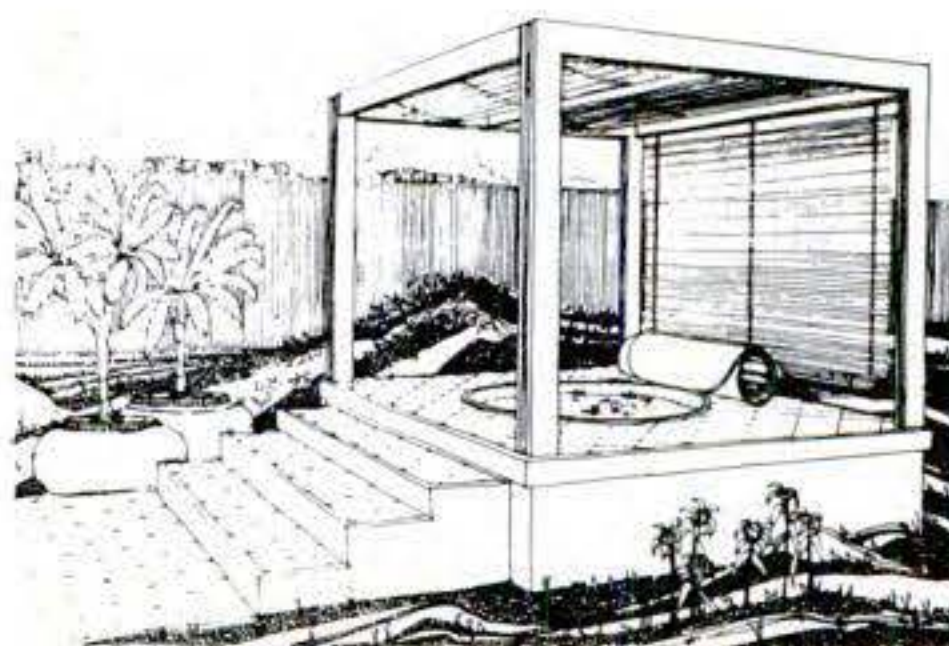
Sodium dichloride and bromine are the most effective disinfectants; the latter is more expensive. Four times a year, the tub should be drained, scrubbed with baking soda, and refilled.

You should test the water's pH balance every third day, or before each use. The pH scale ranges from 0 to 14, with 7 neutral; a reading under 7 means the water is acidic and an alkaline (usually soda ash) should be added; a reading over 7 calls for the addition of acid (handle with care). Proper pH range for hot tubs is slightly alkaline: 7.2 to 7.8. An improper balance can damage equipment, void warranties, and reduce effect of disinfectants.

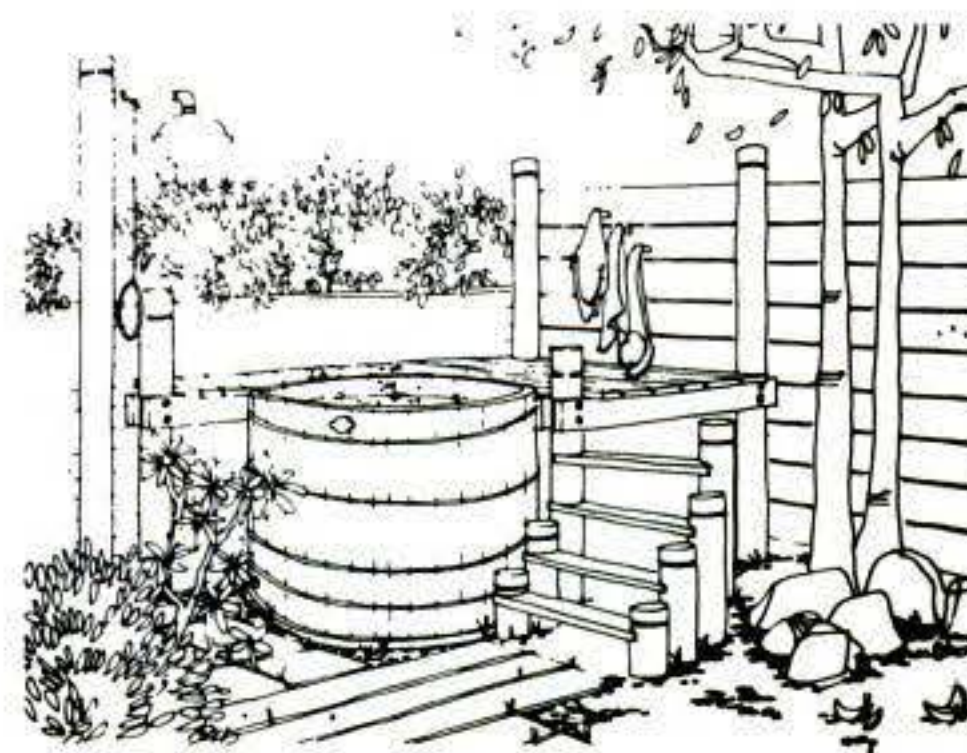
Your pick of hot-tub locations



Three sketches from California Coopers' 60-page Architectural Guidebook



show wide range of installations possible: in lean-to solar greenhouse (left), a cano-



pied backyard spa (center), and with rustic step-up access near a leisure home.

How to make a **wind-site analysis**

Before you buy a windmill, find out how much energy you can get from the wind

By JEANNE McDERMOTT
PHOTO BY GREIG CRANNA

Windmills are tempting alternatives to paying the monthly utility bill. "But windmills are not for everyone," says Peter Martel, who handles site surveys for Natural Power, a distributor in New Boston, N.H. A wind machine makes sense only if you have enough wind to run it.

To choose an appropriate wind system, you need to know your requirements for electricity: How much do you use? When do you use it? What does it power? Start with old utility bills. Examine them on a month-by-month basis to see how many kilowatt hours you use. Make a yearly total. Next, break down the monthly costs by examining your loads.

List and number the electrical appliances, paying particular attention to the big energy consumers: the air conditioner, clothes dryer, freezer, refrigerator, stove, and water and space heaters. List the watt rating of each appliance. Finally, check the voltage and amperage of your electrical service. Voltage will be either 110 or 220; amperage is labeled on the main disconnect switch.

To analyze your wind resource, you must monitor windspeeds. To do this you need to know how to site the monitoring equipment. The best place to begin is with an understanding of the wind: It's a stream of moving air whose motion is created by different atmospheric pressure at different locations. Air flows from high- to low-pressure regions. On a grand scale,

the air streams follow planetary patterns, such as the easterly and westerly trade winds. On a smaller scale, air streams are affected by the contours of the local landscape.

Local winds are as specific to a site as fingerprints to a hand. At any given location, the windspeed and direction is influenced by whatever breaks the path of the air flow. The windiest places are open and unobstructed landscapes such as shorelines and flat, open plains. In such areas, the air meets little resistance. Mountaintops and hilltops are windy because the air stream accelerates as it passes over them. Calmer landscapes tend to have rougher terrain where hills, trees, and buildings break the air flow near the earth's surface.

The wind picks up speed with altitude (see drawing). A rule of thumb says that velocity increases as the one-seventh power of the distance from the earth's surface. This increase is related to turbulence: At greater distances from the ground, the hindering effect of obstructions is minimized.

It's important to know how barriers slow down the wind because you'll want to set up your monitoring equipment—and eventually your wind machine—in smooth air. "The biggest problem we face with people doing a site survey in forested areas is getting the equipment above the trees," says Ned Coffin of Enertech, a wind-turbine distributor in Norwich, Vt. The quickest (though perhaps not most accurate) way to gauge how far up you need to go to find smooth air is to fly a kite (see drawing).

Although each location is unique, some general guidelines can be helpful in siting monitoring equipment. Say you want to site a machine near a

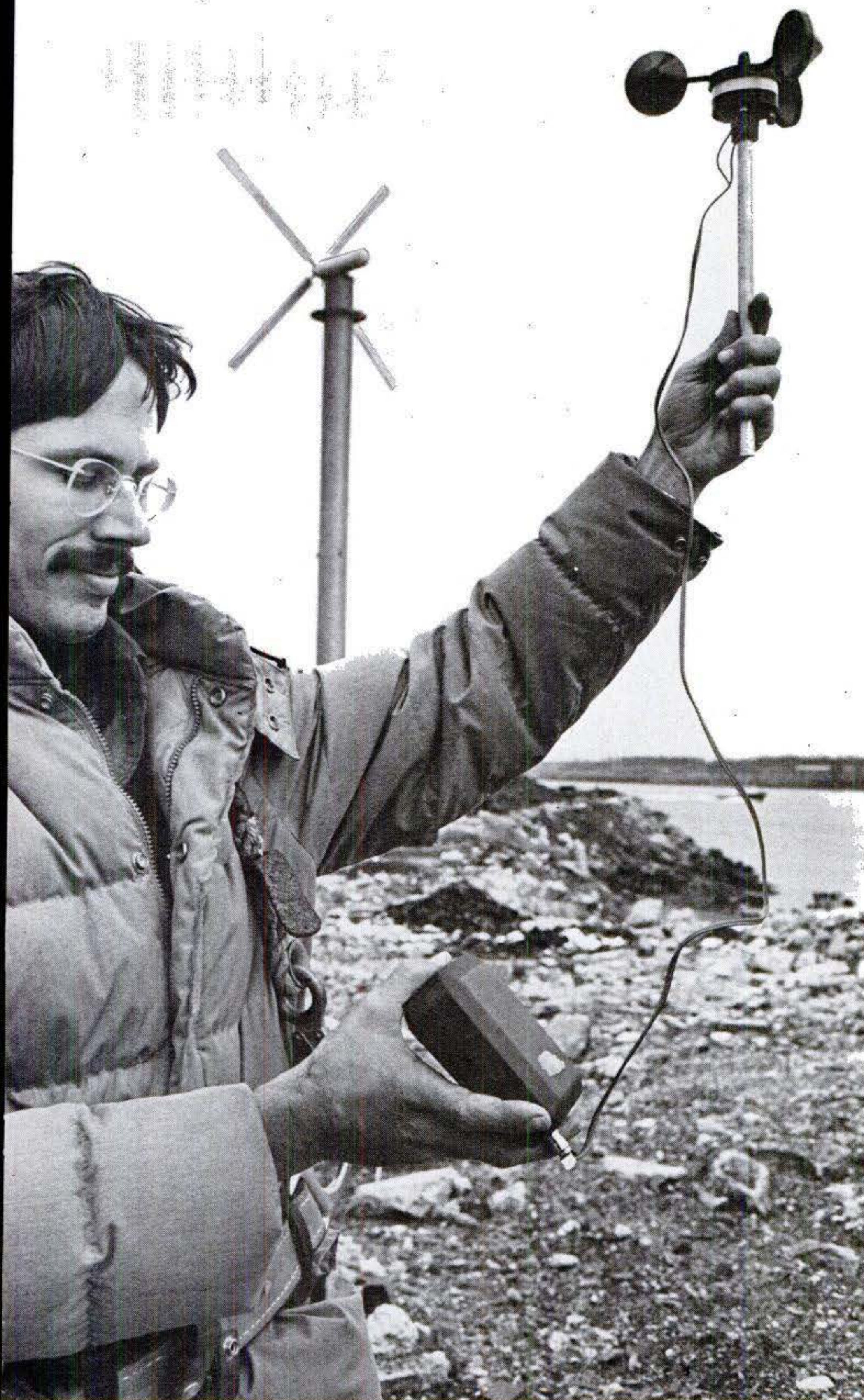
two-story building that's 20 feet tall. Like a boat moving through the water, the structure creates a wake in the air stream. "To be clear of the turbulence, you must site the monitoring equipment far away from any obstruction—or above it," explains Ted Finch, a wind-energy consultant in New York City. Battelle Pacific Northwest Laboratory suggests that if you site the equipment upwind, you should raise it off the ground at least 40 feet, twice the building's height. You can also site it downwind 200 feet, a distance 10 times the building's height. Or you can keep the equipment close to the house and go up at least 60 feet, three times the building's height.

Monitoring for windspeed

The key element in planning a wind system and living with it is to understand that the wind follows daily, monthly, and yearly patterns that can be roughly characterized but never exactly predicted. You must measure your site's wind potential accurately, but measurements that iron out the range of variations are costly, both in time and in sophisticated monitoring equipment. For the homeowner who has a limited number of sites available, the most useful site characteristic is the annual average windspeed. Based on that alone, you can decide if you have enough wind to justify a machine.

Before taking any measurements, ask yourself if the site is worth investigating. For a wind machine to be cost-effective today, you probably require annual average windspeeds of at least 10 mph.

You may know how fast the wind blows on your site from familiarity and experience. If you don't know, consult the nearest weather station.



Wind-energy consultant Ted Finch holds measuring equipment at wind-turbine

Weather stations—run by airports, the national weather service, the park service, military bases, air-pollution testing stations, and universities—keep records of local wind characteristics. If the weather station is close to the site, both in distance and in similarity of the landscape, it's a good bet that your site gets nearly the same annual average windspeeds. "If the reading from the local weather station shows anything above 12 mph, you

site in the Bronx, N.Y. Cup-type anemometer is attached by cable to recorder.

probably don't even need to mess with monitoring," says Ben Wolff of the American Wind Energy Assn.

For a site that shows windspeeds of 10 to 12 mph, the next step is monitoring. Accuracy is critical here. A wind machine on a site with 12.5-mph windspeeds produces *twice* as much power as a windmill on a site with 10-mph winds. That's because the available power in the wind varies as the cube of the windspeed.

The simplest and most widely available device for measuring windspeeds is a wind odometer. It is a cup-type anemometer with an odometer attached that advances one count for every mile of wind run (see photo). "It works the same way as a car odometer," says Ned Coffin. The anemometer is raised on a pole and the odometer's readout unit is attached by a cable to ground level.

Daily readings

You take daily readings at regular intervals: for example, one each day at noon, or once in the morning and once in the evening. At each reading, record the date, time, and readout number. At the end of the data-collection period, you can figure average site windspeeds by calculating the differences between consecutive readout numbers and the time differences between consecutive readings. Divide the readout numbers by the hours that elapsed, and you'll get the average windspeeds for that period. Average the windspeeds for the entire monitoring period and you'll obtain an average for those months.

From your monitoring results, you can estimate how much wind you are likely to get in a year (the annual average windspeed) by correlating your data with that from a nearby weather station. Take the average speeds at both sites during the monitoring period. Divide your average by the average speed at the nearby weather station and you'll get a correlation factor. To find your site's annual average windspeeds, multiply the weather station's annual average by your own correlation factor:

	My site	Weather station
Jan.	11 mph	11.5 mph
Feb.	12 mph	12.7 mph
March	11 mph	11.6 mph
Average	11.3 mph	11.9 mph

Correlation:

$$\frac{\text{My site: 11.3 mph}}{\text{Weather station: 11.9 mph}} = .95$$

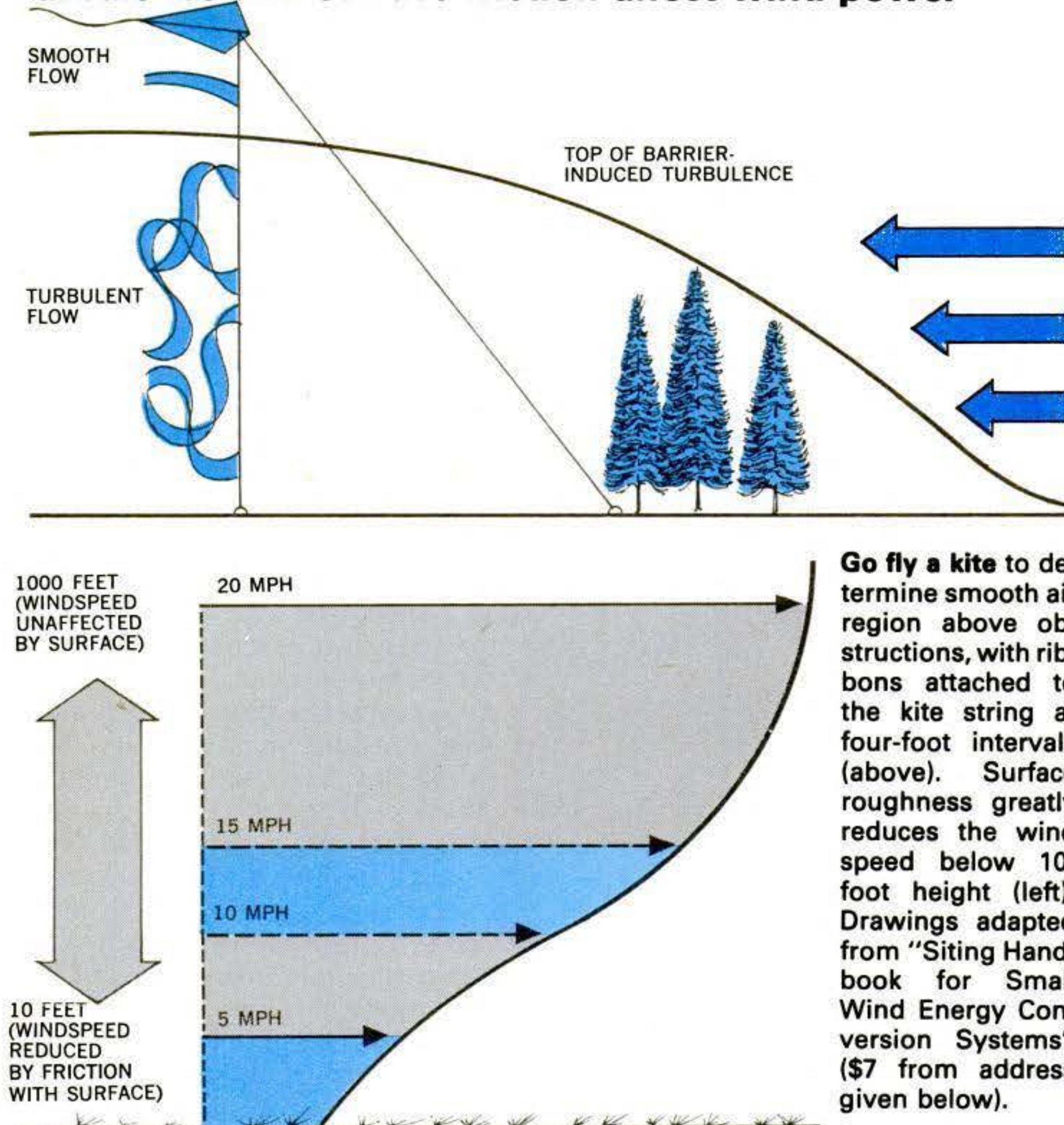
Weather station's annual average:
 $12.1 \text{ mph} \times .95 = 11.5 \text{ mph}$
 (my site's annual average)

To raise the odometer, telescoping poles are recommended. You can buy a 50-foot telescoping pole from Radio Shack, Enertech, Natural Power, or through a windmill distributor. Expect to pay about \$65. You'll need to stabilize the pole with guy wires.

The last part of a general site analysis is to draw up a map of your site. Mark your monitoring site as well as buildings, trees, and other obstructions. Note elevations and distances

Continued

Turbulence and surface friction affect wind power



Go fly a kite to determine smooth air region above obstructions, with ribbons attached to the kite string at four-foot intervals (above). Surface roughness greatly reduces the wind speed below 10-foot height (left). Drawings adapted from "Siting Handbook for Small Wind Energy Conversion Systems" (\$7 from address given below).

from each other. A windmill dealer will need this information to help you select the best system for your site.

Shopping for systems

Once you've analyzed your energy needs, calculated your annual average windspeeds, obtained a year's worth of data from the nearby weather station, and mapped the site, you are ready to shop for a wind-energy conversion system. Based on the information you've gathered, a windmill distributor can give you an approximate figure for a cost-effective system. "Cost-effectiveness is a function of low initial costs, good kilowatt-hour production, and high competing fuel costs," observes Ted Finch.

Costs are a composite of many variables, including tower height, type of storage, utility interface, maintenance, wiring, insurance, and labor. Effectiveness depends primarily on how much power the system produces. Power production is also a function of many variables, including how often and fast the wind blows, at what windspeed the generator starts producing power, how much power the generator produces at any given windspeed, and how efficiently the system works. In the two-kW to 10-kW market, expect to pay in the range of \$1500 to \$4000 per installed kilowatt (the lower fig-

ure applies to machines with higher ratings).

ACKNOWLEDGEMENT

The author would like to thank Ted Finch for his help in preparing this article.

FOR MORE INFORMATION

In addition to handbook mentioned in caption above (from NTIS, 5285 Port Royal Rd., Springfield VA 22151), read one or more of these sources before you undertake a site analysis: "Planning a Wind-Powered Generating System," available for \$2 from EnerTech (address below). *Harnessing the Wind for Home Energy*, by Dermot McGuigan, \$4.95 from Garden Way Publishing, Charlotte VT 05445. "Site Selection and Evaluation Handbook for Wind Energy Systems," by Steve Blake, \$8.50 from Sunflower Power Co., Box 93A, Oskaloosa KS 66066. The American Wind Energy Assn. (1621 Connecticut Ave. N.W., Washington DC 20009) will send a useful brochure, free. Another useful source: "Wind Energy Information Directory," prepared by the Solar Energy Research Institute (Stock No. 061-000-00350-9, Superintendent of Documents, GPO, Washington DC 20402).

Wind-measuring equipment sold by **EnerTech** (address below); **Natural Power** (Franconia Turnpike, New Boston NH 03070).

WIND-TURBINE MANUFACTURERS

Aerolectric, 13517 Winter La., Cresaptown MD 21502; **Aero Power**, 2398 Fourth St., Berkeley CA 94710; **Aerowatt, S.A.**, c/o Automatic Power, Inc., Box 18738, Houston TX 77023; **Altos: The Alternative Current**, Box 905, Boulder CO 80302; **American Wind Turbine, Inc.**, 1016 E. Airport Rd., Stillwater OK 74074; **Dakota Wind & Sun, Ltd.**, Box 1781, 811 First Ave. NW, Aberdeen SD 57401; **Dominion Aluminum**, 3570 Hawkestone Rd., Mississauga, Ont. Canada L5C 2V8; **Dynergy Corp.**, Box 428, 1269 Union Ave., Laconia NH 03246; **EnerTech Corp.**, Box 420, Norwich VT 05055; **Grumman Energy Systems**, 4175 Veterans Memorial Hwy., Ronkonkoma NY 11779; **Kedco, Inc.**, 9016 Aviation Blvd., Inglewood CA 90301; **Millville Windmills & Solar Equipment Co.**, Box 32, 10335 Old Dr., Millville CA 96062; **North Wind Power Company**, Box 315, Warren VT 05674; **Pinson Energy Corp.**, Box 7, Marstons Mills MA 02648; **Product Development Institute**, 508 S. Byrne Rd., Toledo OH 43609; **Sencenbaugh Wind Electric**, Box 11174, Palo Alto CA 94306; **Winco**, Div. of Dyna Technology, 7850 Metro Pwy., Minneapolis MN 55420; **Wind Power Systems, Inc.**, Box 17323, San Diego CA 92117; **W.T.G. Energy Systems, Inc.**, Box 87, 1 LaSalle St., Angola NY 14006; **Zephyr Wind Dynamo Co.**, Box 241, 21 Stamwood St., Brunswick ME 04011.

Grass growth suppressor

—spray it on and the lawn stays mowed



Summertime. With temperatures in the 90's and the humidity high, too, that hammock swaying in the backyard looks so inviting... but you have to mow the lawn, right?

Maybe not, thanks to a new product developed by the 3M Corp. of St. Paul, Minn. Instead of mowing every week in spring and summer, you may soon be able simply to spray Embark plant-growth regulator on your lawn—and mow only twice a year.

When sprayed on grass, Embark is absorbed by the leaves and penetrates down to the roots. It slows growth and inhibits seed-head formation. Spring application can extend suppression until normal turf-growth slowdown in midsummer, 3M claims. While it doesn't work on all grasses, it does minimize for eight weeks the turf growth of those found in the northeastern or western parts of the U.S., such as Kentucky bluegrass, tall fescue, and Bermuda grass.

Right now, Embark is available only to commercial buyers such as golf courses and cemeteries. "The product appears to have an excellent potential as a future home lawn product, but it is not a wonder treatment," cautions M. G. Shaver, a market-development manager for 3M. It does not, for example, control weed growth. Weed killers and other lawn-maintenance products must still be used.

But, according to 3M, commercial users have reported that Embark cuts the costs and labor of keeping a lawn short. The New York Department of Transportation will give the spray its first broad-scale test this summer on over 1000 acres of government-owned land. If all goes well, who knows? In a few years you may be sitting back in that hammock and watching the grass not grow.—Harriet Brown

Get better pest control with **UV bug killers**

Skip the chemical warfare this summer. Try one of these plug-in protectors

By **EVAN POWELL**

There's no escape. Just step outside and you become the main meal of gnats, mosquitoes, and any other flying bug that likes to bite or stick humans. And our only defenses have been just as uncomfortable: sticky sprays, irritating fogs, and smelly repellents. But there's an alternative—black-light (ultraviolet) insect killers.

These devices eliminate pesty bugs without using nuisance—and possibly dangerous—insecticides. And the new models are designed for home use: hanging decorative boxes with equally attractive price tags—as low as \$49.95.

But that's the starting price. You can spend 10 times that amount for some models. Will they kill 10 times more bugs? Are different types more effective than others? Will *any* let you totally regain your backyard turf this summer?

To find out, I spoke to leading scientists who work in this field, to manufacturers, and to people who have used bug lights. I also gathered some representative models to try out myself. Here's what I learned.

How they work

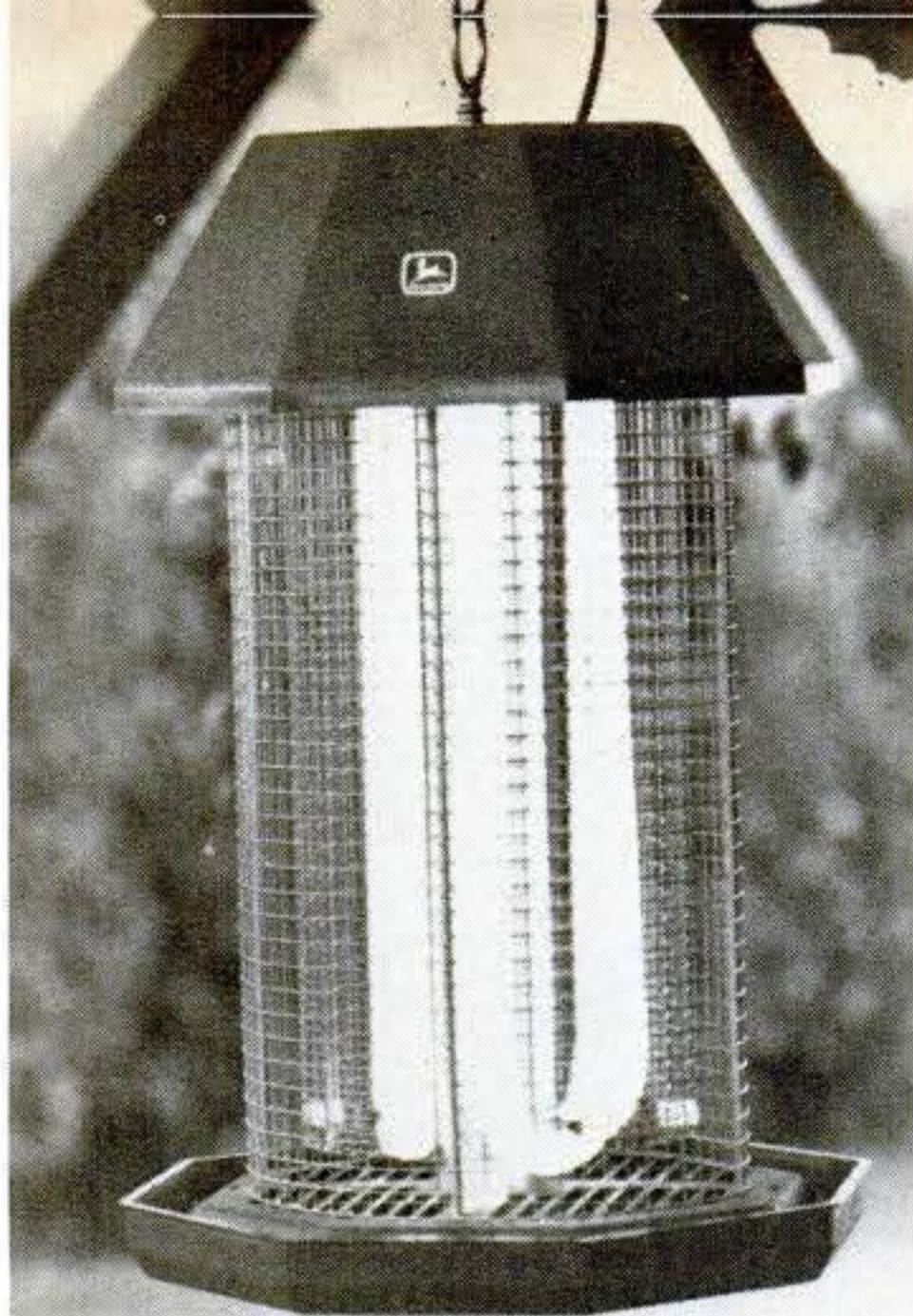
They come with all sorts of catchy names—Insect-Aside, Zonker, Bug Popper, The Web, Zap—but they all work on the same basic principle. Many insects we want are phototropic, attracted to ultraviolet or "black" light. Add an ultraviolet light source to some mechanism for catching or ex-

Continued

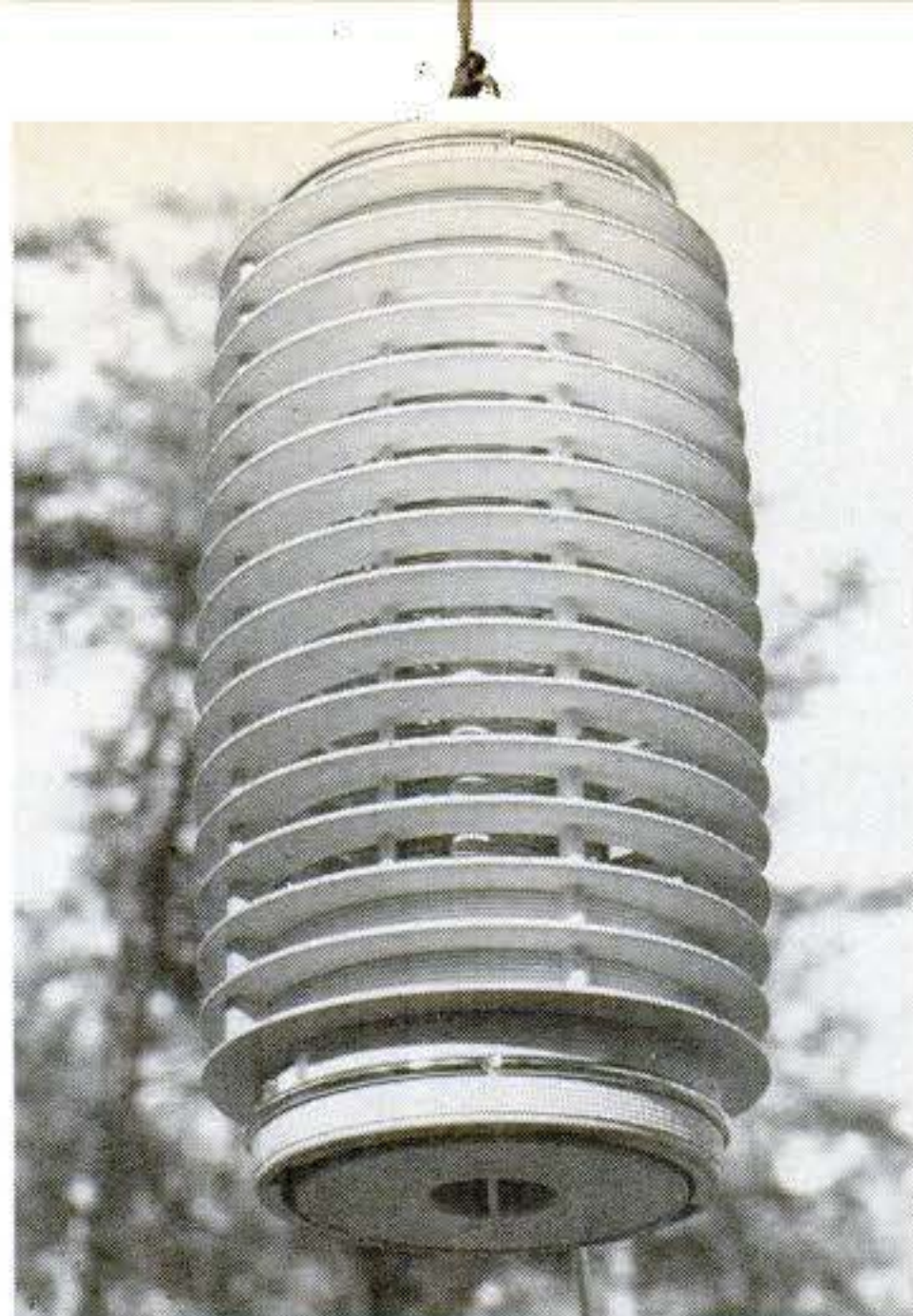


Flowtron's 4500 volts takes the place of insecticides or sprays. Shown on optional

mounting pole, it uses two 25-watt black lights inside a charged grid.



Heavy-duty 145-watt John Deere unit uses three black-light bulbs. High intensity is used to lure less sensitive flies.



Insect-Aside uses only 10 watts of power. Low, 450-volt grid maintains an effective kill, but without "popping" sound.



Charmglow has 30-watt U-shape lamp with 5000-volt grid. U-shape keeps all electronics tightly sealed at one end.

terminating the critters, and the result is a bug killer.

The differences start with the lamps themselves. Two types are used: black light (BL) and black light blue (BLB). Both peak at the same wavelength, about 3573 angstroms, but the different glass of the BLB filters out most of the visible light. Some USDA tests indicate that most night-flying insects find the BL lamp more attractive and that houseflies are more prone to zero in on the BLB. I found that the type made little difference for home use—both worked for me.

Rather than type, it's the amount of light that's important. For example, the \$49.95 Insect-Aside and Katlan units use a four-watt lamp. For more money you get more light output.

"More powerful lamps are more attractive to insects, but it's not necessarily a straight line," says Dr. Hernon Agee, research entomologist at the USDA's Insect Attractants, Behavior, and Basic Biology Research Laboratory in Gainesville, Fla. "Thirty watts might get *more* bugs than 15, but probably not twice as many," he says.

The biggest difference you'll find in bug killers is in the way the bugs are collected once they're attracted by the light. Three of the Pestolite units I tested used a fan to blow them into a pool of water, or catch them on a sticky flypaper-like substance. But according to expert entomologists and my own observations, the "electronic"—actually, electric—type is far more effective.

These use a high-voltage step-up transformer to charge negative and positive grids, which are spaced about a half-inch apart and surround the lamp. Once an insect enters this field, it's all over. The voltage used ranges

from under 500 V to 5000 V, depending on the price of the unit. The higher voltage guarantees that the unit won't clog up—and that the bug won't come out in the same condition that it went in.

All of the electronic models I used seemed to be amply durable. Most models priced above \$150 are commercial units intended for use around high-intensity lighting and for fly control. Flies are less photosensitive than night-flying insects, and it takes more light to attract them. Some models, including the Flowtron and Insect-Aside units I tested, have a bait tray to lure those bugs that don't go for the light. The tray can also collect insect fragments for feeding pet fish.

How effective are they?

They're efficient, in the sense that the electronic type will zap nearly all insects that come within its field—but that's hardly every high-flyer in your yard.

But claims go far beyond the mere elimination of insects in the immediate vicinity of the light. Manufacturers say that a properly located device controls the insect population by interrupting the breeding cycle; supposedly, you'll notice a difference in the infestation after about 10 days.

When you zap an insect, there's little doubt that you've interrupted *its* breeding cycle, but the degree to which the insect population is reduced is open to speculation. The USDA's Agee doubts that it's significant. "It's all relative," he says. "An individual's satisfaction with a light trap depends on his tolerance level for insects and what he expects from it."

Dr. R. Michael Peters, acting head of the Entomology Department at the University of Massachusetts, agrees.

"It is unlikely that you would ever trap enough insects to significantly reduce the total population," he told me. And further complicating the issue, "studies indicate that the mosquito's sensitivity to black light varies significantly during its typical two-to-four-week life span." That leaves much to luck.

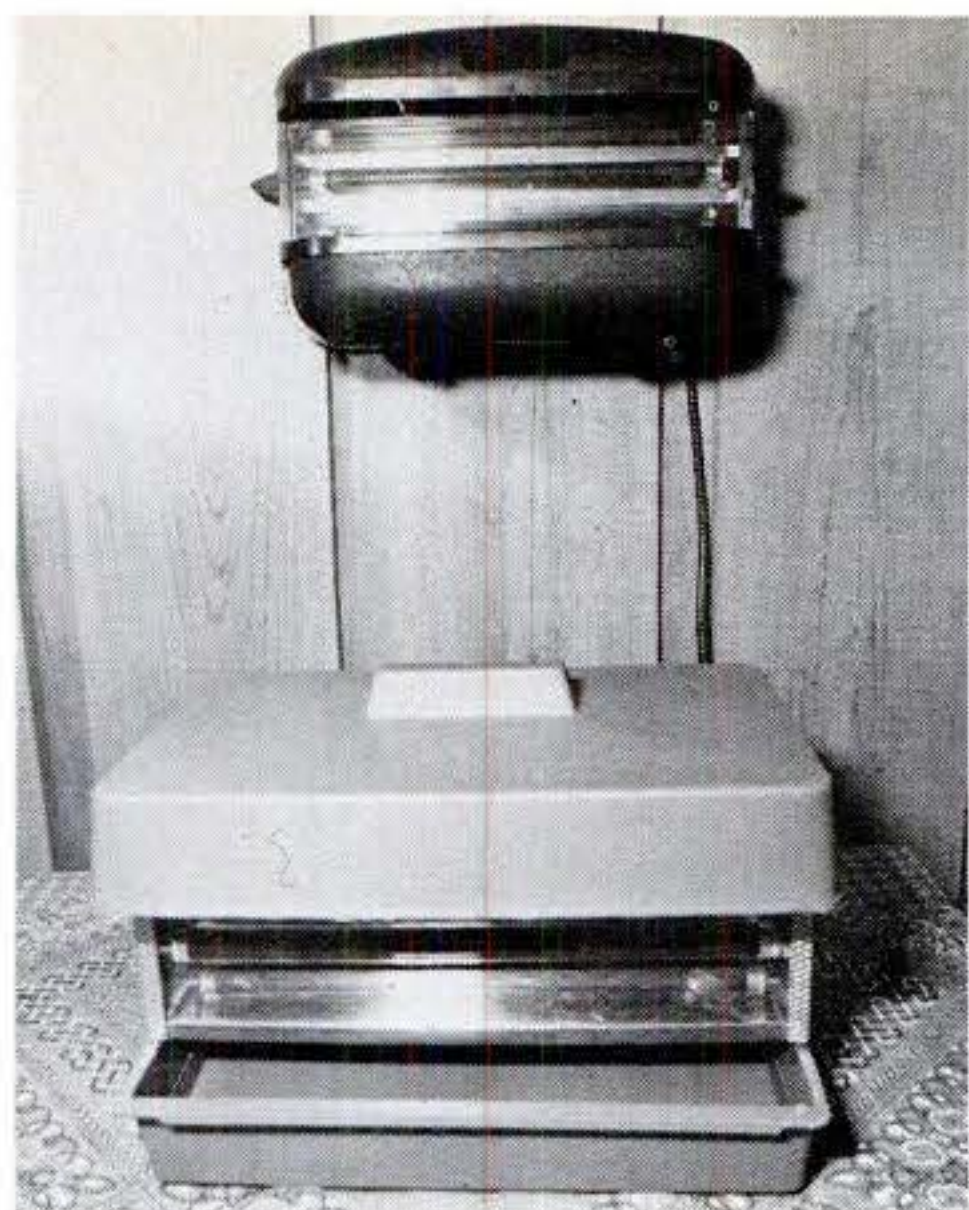
Surprisingly, the devices' most enthusiastic proponents are those who have used them for a season or two. That may be partly psychological—there's no doubt that the flash and pop of a mosquito meeting its doom in a trap are infinitely more satisfying than a slap on the arm.

What to look for

Style and price will likely determine your choice. The advantage of the "water puddle" and flypaper traps over the electronic type is that there is no noise or flash—a point to consider if there are close neighbors. But they are less effective and messier. If you're looking for something to take camping, check the Insect-Aside and Katlan models. They are small and are available in 12-volt versions.

I judged models in the \$120–\$150 bracket to be the best overall for home use. (Check stores carefully; many are discounted below \$100.) They cost little to operate (about 75 cents a month for a large unit in most areas) and become extremely efficient when you consider what you pay for sprays and repellents during a season.

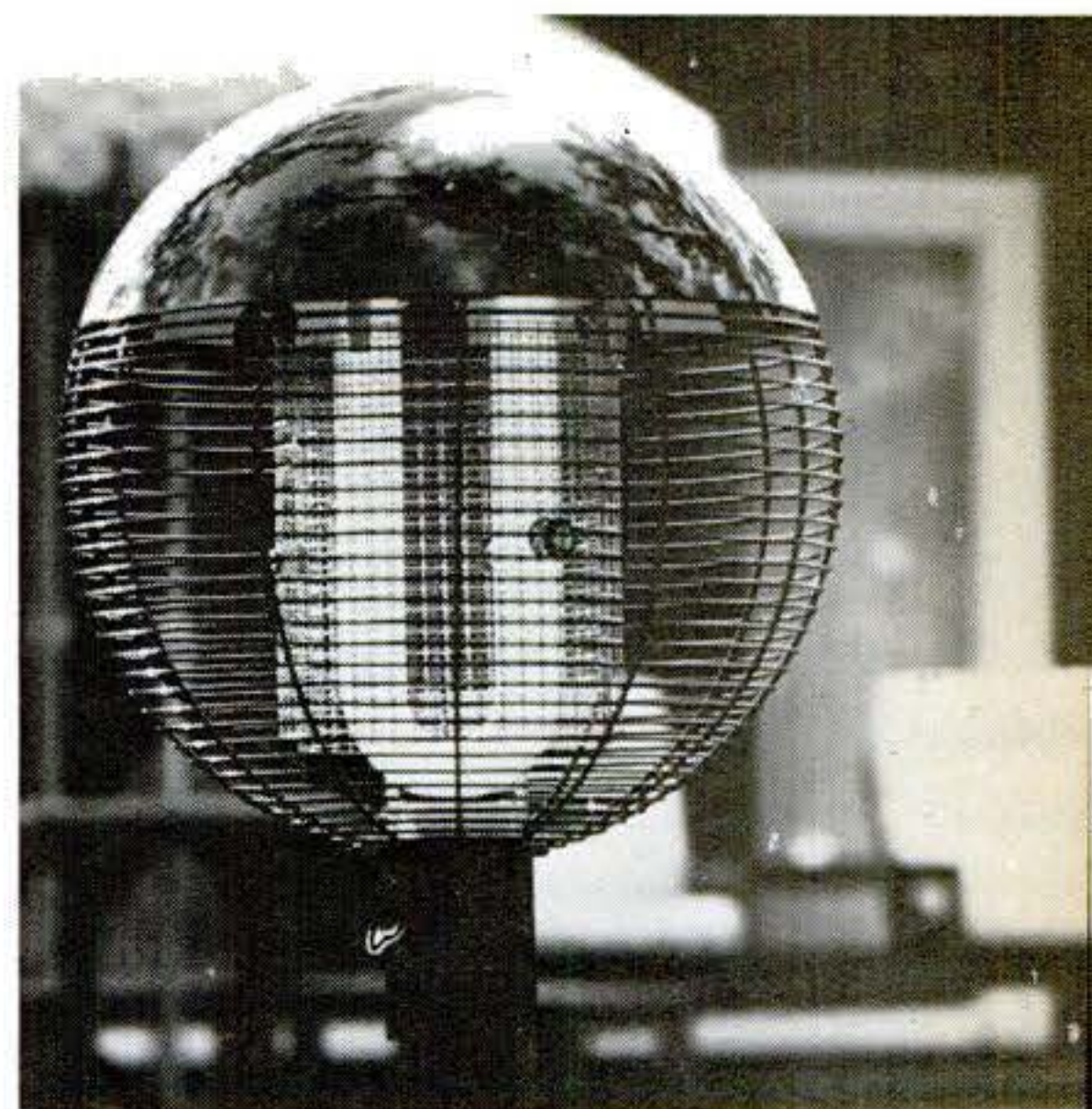
The neutral gray and beige, square plastic housing of the Charmglow makes it the most inconspicuous, and it wipes clean easily. I also like the lantern styling and heavy vertical grids of the Flowtron; all these high-powered units are largely "self-cleaning," but the Flowtron does better



Pestolite pool and patio models use water troughs to snag insects. Shields on three sides make them directional.



Denalco unit comes in kit form; you save money by building it yourself. It uses two U-shape BL lamps, high-voltage grid.



The Web from Weber is available with an optional mounting pole or a wall bracket. It uses 30 watts of power.

than the others in this respect. Poles, posts, and brackets are available for many models. The circular styling of the Weber and Katlan models is especially attractive when pole mounted. Most large commercial-type units are rectangular in shape.

Using a bug light

Use a grounded outdoor cord when the trap is equipped with a three-prong plug. That's not only for safety, but it helps start the lamp in cool weather. Many manufacturers recommend burning the lamp 24 hours a day, but I see no point in using it in daylight. Its ultraviolet output just can't compete with the sun.

Little maintenance is required, but you should clean the grids and the lamp about once each season. If a continuous arcing occurs on the grid, it's time for cleaning. If it isn't as effective after several seasons, it's time to replace the lamp. Don't stare at the lamp at close range.

And remember, it attracts insects, so install it about 20 feet away from the protected area, and don't place it in the direction of the setting sun.

You must also consider another factor: The lamp must usually compete with other light sources in your yard. If you have high-intensity lighting near the area you're trying to protect, choose a more powerful unit.

Bug lights should be placed between the protected area and the area of infestation, usually the densest vegetation in your yard. You must also be sure that no light reflects from light-colored walls or windows, luring the insects to the very area you're trying to protect. As Clemson University entomologist Sid Hayes commented, "The ideal may be for a neighbor to have an insect light in *his* backyard."

PS buyer's guide to UV bug killers

Name and manufacturer	Model	No. of lamps/ watts/type	Collection type *	Price (\$)
Bug Popper	102	2/20/BL	E	179.95
Environmental Systems Corp.	205	2/15/BL	E	149.95
Peterboro Rd., Jaffrey, N.H. 03452	105	1/15/BL	E	115.95
Charmglow (Rid-O-Way)	8153	1/15/BL	E	79.95
Charmglow Products	8155	1/15/BLB	E	119.95
Box 127	8305	1/30/BLB (U-shape)	E	149.95
Bristol, Wis. 53104	500	1/15/BLB (U-shape)	E	64.00
	600	2/15/BLB (U-shape)	E	104.00
John Deere	TY 15125	1/20/BL	E	89.95
Deere & Company	TY 15126	2/20/BL	E	124.95
John Deere Rd.	TY 15127	3/40/BL	E	179.95
Moline, Ill. 61265				
Denalco	Single-bulb kit	1/20/BL (U-shape)	E	59.95
Denalco Corp.	Double-bulb kit	2/20/BL (U-shape)	E	69.95
201 S. Eighth St.	Single-bulb assembled	1/20/BL (U-shape)	E	99.95
Geneva, Ill. 60134	Double-bulb assembled	2/20/BL (U-shape)	E	109.95
Flowtron Bug Killer	BK-2000	1/15/BL	E	99.95
Flowtron	BK-3000	1/15/BL	E	119.95
2 Main St.	BK-4000	2/25/BL	E	135.95
Melrose, Mass. 02176	FC-8500	3/30/BL (U-shape)	E	199.95
	FC-9000	3/40/BL (U-shape)	E	219.95
Insect-Aside	Patio	1/4/BL	E	49.95
Piped Piper Industries	Camper (12-volt)	1/4/BL	E	54.95
2201 E. 18th St.	Commercial	1/40/BL	E	250.00
Cleveland, Ohio 44115				
Insect-O-Cutor	2011-T (interior)	1/32/BL	E	220.00
1531 Stone Ridge Dr.	332	2/20/BL	E	275.00
Stone Mountain, Ga. 30083	2011	1/32	E	205.00
Kalglo	IK-40B (int. or under roof)	2/20/BL	E	199.95
Kalglo Electronics, Inc.	IK-40 (int. or under roof)	2/30/BL	E	200.00
Box 2062				
Bethlehem, Pa. 18001				
Katlan	Super	1/4/BL	E	49.95
Amcor Group, Ltd.	Super Camper (12-volt)	1/4/BL	E	49.95
350 Fifth Ave., Suite 1907	Katlan 25	1/25	E	129.95
New York, N.Y. 10001	Professional	1/20	E	179.95
Pestolite, Inc.	SK-7 (interior)	1/4/BL	P	29.95
208 Centerville Rd.	RD-1P (patio-pool)	1/8/BLB	W	59.95
Lancaster, Pa. 17603	SK-14 (patio-pool)	1/8/BLB	W	59.95
Sunbeam Corp.	SBK-65	1/20/BL (U-shape)	E	149.00
2001 S. York Rd.	SBK-66	2/20/BL (U-shape)	E	169.00
Oak Brook, Ill. 60521	SBK-77	2/40/BL	E	219.00
Vandermolen Bugkill	151	1/20/BL (U-shape)	E	119.50
Vandermolen Corp.	440	1/40/BLB (U-shape)	E	169.95
119 Dorsa Ave.	E200	2/40/BL (U-shape)	E	209.95
Livingston, N.J. 07039	E484	2/40/BL (U-shape)	E	189.95
Weber	The Web 23521	1/25/BL (U-shape)	E	175.00
Weber-Stephen Products Co.	The Web 23522	2/25/BL (U-shape)	E	209.95
100 North Hickory Ave.				
Arlington Heights, Ill. 60004				
Zap	Mr. Zap G-25	1/25/BL	E	199.00
Gardner Mfg. Co.				
Horicon, Wis. 53032				
Zonker	12184-TG (interior commercial)	2/20/BL and BLB	E	305.00
Chase Industries, Inc.				
8100 Reading Rd.				
Cincinnati, Ohio 45222				

* E=electronics, P=paper, W=water

Solving problems that plague **auto locks**

Worn keys, broken cylinders, vulnerable trunk locks—you can doctor them all

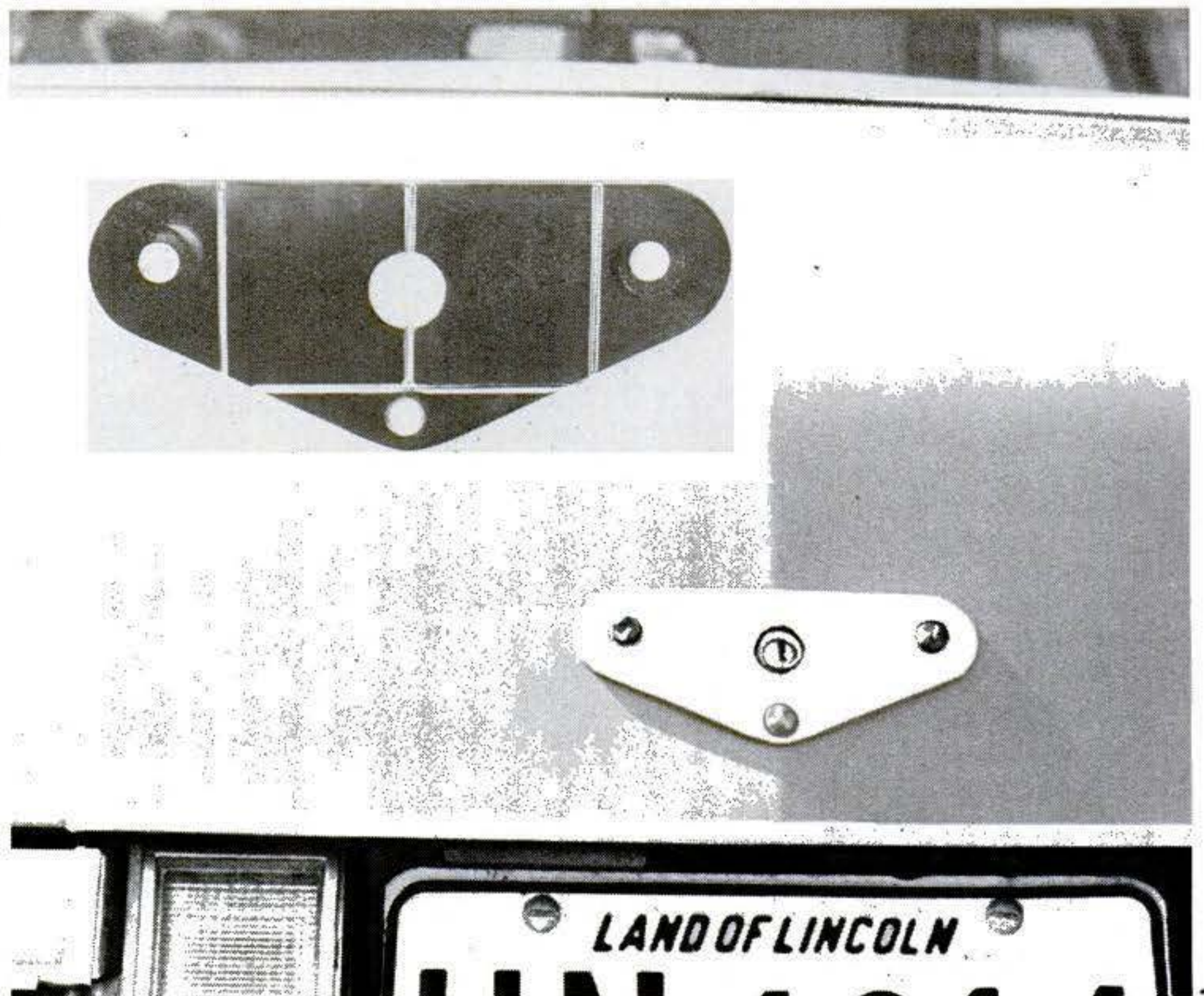
By **DENISE GREEN**

You use your car keys several times each day, probably without a moment's thought. But if you are locked out—or can't lock your car when you park it—you have a real crisis. If you can pinpoint and correct problems before they arise, you'll save yourself some headaches—and cash.

The first symptom of a faulty lock often is difficulty in inserting the key. If it's a door lock, especially on the driver's door, it's probably only dirty. Flush the lock well with WD-40 or LPS #1, lubricant sprays that are widely available. Never use oil of any kind in the keyway of a lock. Liquid or (worse) dry graphite, which are used on indoor locks, will only worsen the condition of a car lock, causing sludge buildup.

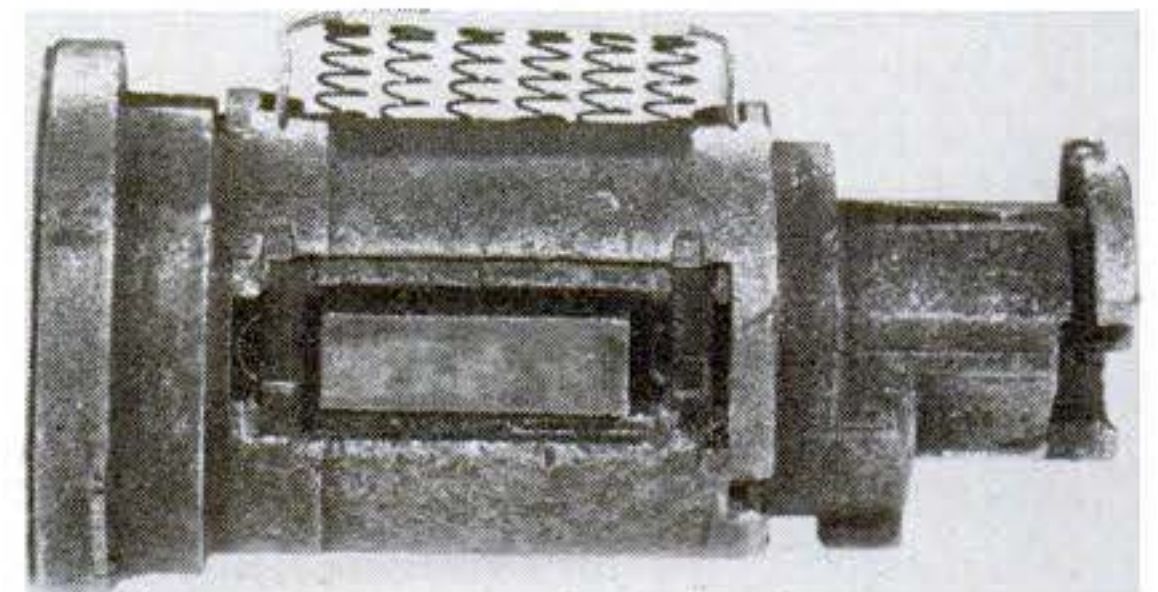
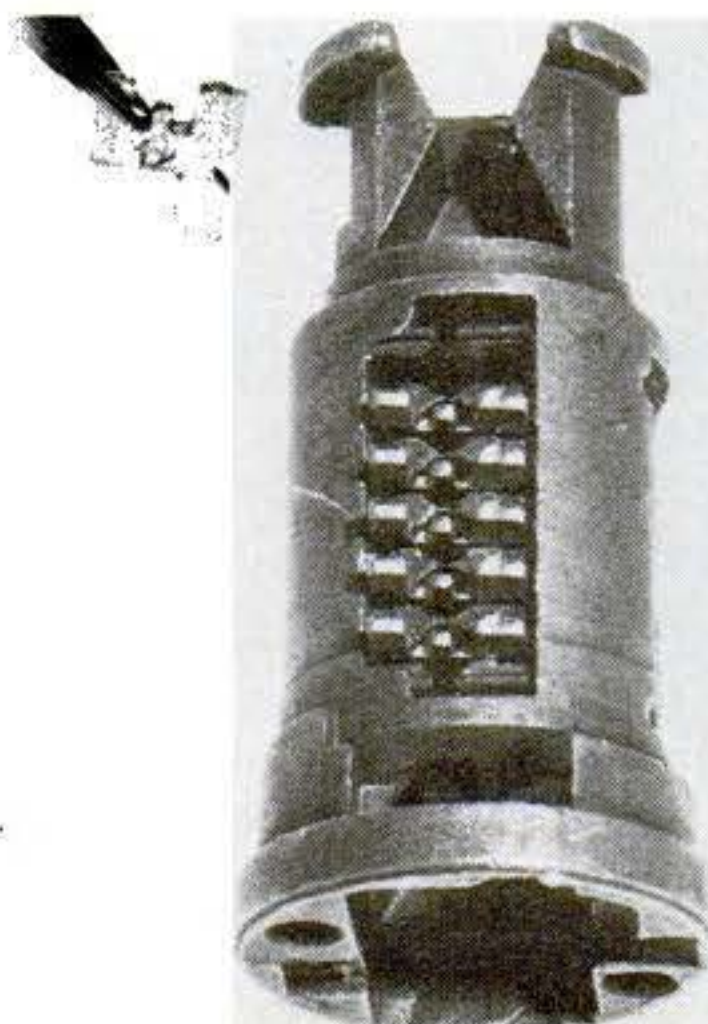
If lubricant doesn't clear the keyway, there's probably something wrong inside the lock, such as a broken spring or a stuck pin or wafer. These problems require the services of a locksmith. Auto dealers and shop mechanics do not repair locks. They will sell you either a new lock having different keys or an uncoded lock (a lock not set to any key), which you must then take to a locksmith to have set to your present key. If possible, remove a balky lock yourself and take it to a locksmith for repairs. To remove the lock, take the trim off the inside of the door and pull out the clip that holds the lock in place against the car door (see photo).

Continued



Guard plates go over locks (with one-way screws) to prevent drilling near the lock.

Scoring on inner surface (inset) allows bending to conform to trunk's contour.

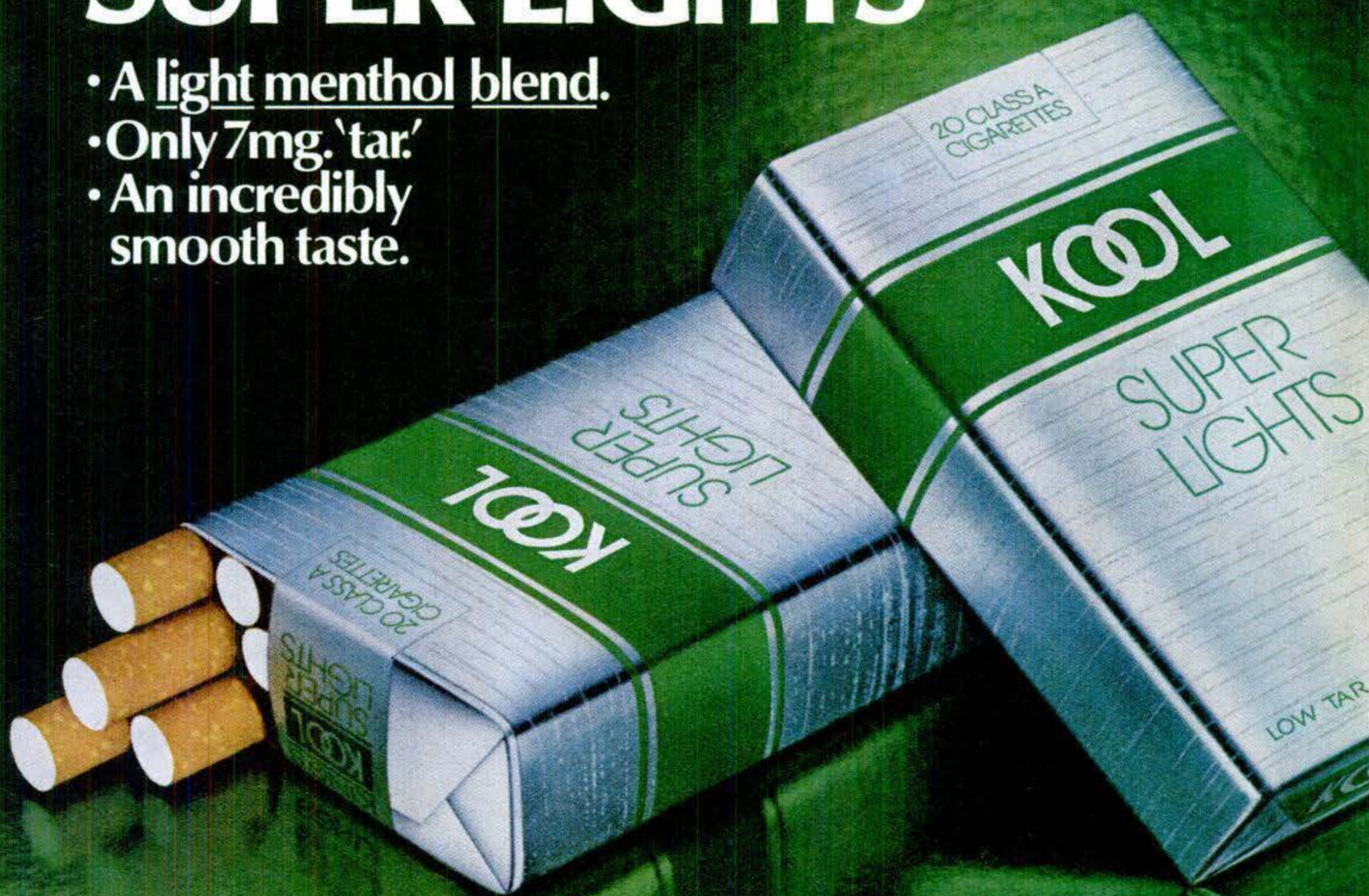


Wafers in GM locks (left) fit into slot in top of lock body. Wafer height corresponds to depth of key notches. Springs atop wafers are compressed and held by a retainer clip (above).

The smooth taste you want in one incredible light.

KOOL SUPER LIGHTS

- A light menthol blend.
- Only 7mg. 'tar.'
- An incredibly smooth taste.



At 7mg. 'tar'
we are lighter than all these.



16 mg. 'tar'

17 mg. 'tar'

11 mg. 'tar'

8 mg. 'tar'

Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

Kings, 7 mg. "tar", 0.7 mg. nicotine av. per cigarette by FTC method.

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Auto locks

[Continued]



Door cylinder (above) is secured with U-shape retaining clip that slides into groove on lock body from inside door.

Newly clipped key (right, top) shows distinct cuts. Original key is in center, showing moderate wear. Key below is so worn that it can't operate lock.



You might find, some time, that you can insert the key into the car-door lock, but that you must jiggle it a lot to get it to rotate. Does your lock need replacing? Probably not. If you have a GM car three or more years old, have your key checked by a locksmith. GM locks have a wafer design that wears keys quicker than the pins in Ford and Chrysler locks.

The locksmith has a gauge to measure key wear. If your key is in bad shape, he can cut a new key for you to

original factory specifications on a special clipper, instead of using the familiar duplicating machine. (A copying machine won't help; it will only duplicate the key that's giving the trouble.) If a new key won't open the lock, take the entire lock to a locksmith for checking.

Trunk locks

If the key goes in your trunk lock and turns but nothing happens, the tailpiece of the lock—the piece that re-

leases the latch—has become disengaged. Perhaps you had the trunk loaded and something caught on the tailpiece, pulling it loose. Even a hard bump from the rear may be enough to pop the tailpiece off the lock. Examine the surface around the lock, too. If there's a small hole beneath the lock, someone has broken into your trunk by drilling the hole and inserting a tool to force the catch. This usually fractures the end of the lock but may not completely break the piece off the lock body.

You may open the trunk once or twice without realizing anything is wrong, but the broken piece eventually separates, the spring holding the tailpiece slips off, and they all drop into the trunk. A guard plate should be installed to cover the hole and prevent reentry. If the key will not open the lock or the telltale hole is under the lock, you can have the lock drilled out and replaced, or you can remove the lock yourself.

To get to the lock, lift the back seats out of the car and crawl toward the trunk with a flashlight. A turn on a screwdriver fitted into the slot on the latch mechanism will pop open the trunk lid. Once the trunk is open, you

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should be able to find the tailpiece and reconnect it if there was no damage to the lock. Be sure to try the lock several times before closing the trunk again. If the lock body was damaged by forcible entry, it will have to be replaced.

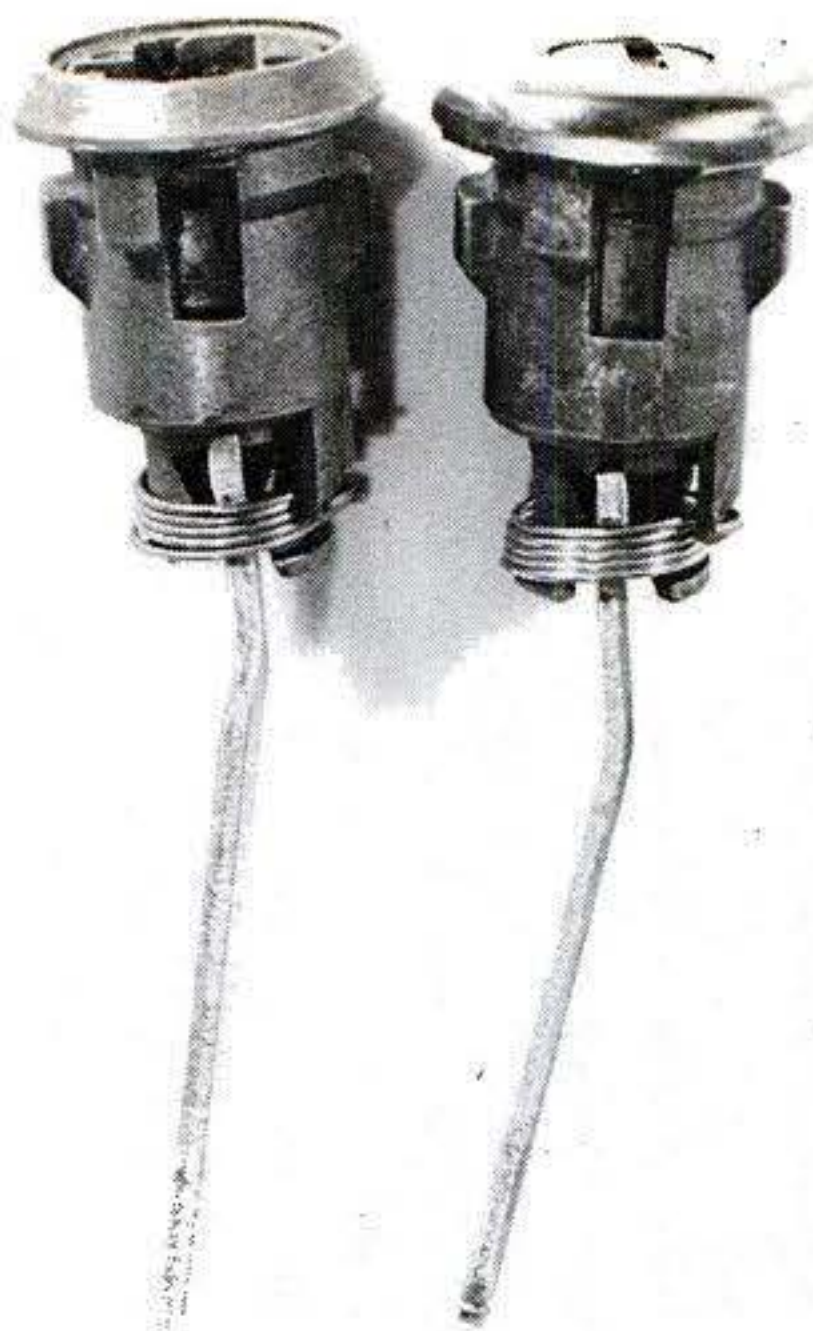
If your key can't be inserted into the trunk lock or it won't turn, try spraying the lock with a lubricant. If that doesn't free it, remove the lock and have it checked out by a locksmith.

Key coding

The code numbers that are supplied with new car keys make it possible for a locksmith to cut new keys for you without an original. Using this code, the locksmith can determine the depth of the cuts in your key. Should you lose your keys, he can cut new ones in a few minutes, if you can supply him with the code number. With GM cars the code is recorded on a rectangular "knockout plug" in the head of the key. These plugs should be removed and the numbers recorded in case of emergency. Ford and Chrysler have code numbers on a separate tag. It's a good idea to record these numbers on a card and carry them in your wallet in case you lose your keys or lock them in the car or trunk. It's faster, easier, and considerably less ex-

pensive to have keys made from these numbers than it would be if you had to call a locksmith to make keys from your existing locks.

Having a new clipped key made will cost more than a machine-made duplicate, but probably no more than \$5 per key. If the locksmith must remove and strip the locks in order to make keys, the price could run anywhere from \$30 to \$100, with the upper range applicable to the newest models.



Chrysler and Ford keys are shown with tags bearing code number. New keys may be cut from this code if keys are lost.

Tailpiece of trunk lock (left) is attached to lock with spring. Note broken corner section at rear of lock, far left, caused by break-in. Spring will eventually slip, and tailpiece will fall off.

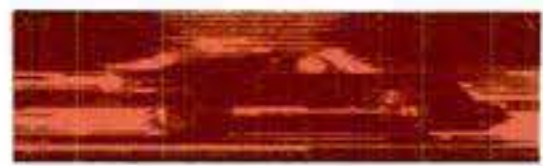
To avoid lock problems, lubricate the locks two or more times a year. At the first sign of a problem, try using a lubricant first. If the key won't turn by jiggling it, don't force it. Any force will only make the problem worse. In this case, consult a professional.

And when you need a locksmith, find one who belongs to a locksmith organization. He's a bonded member of the profession, not someone who works at it in his spare time. **PS**

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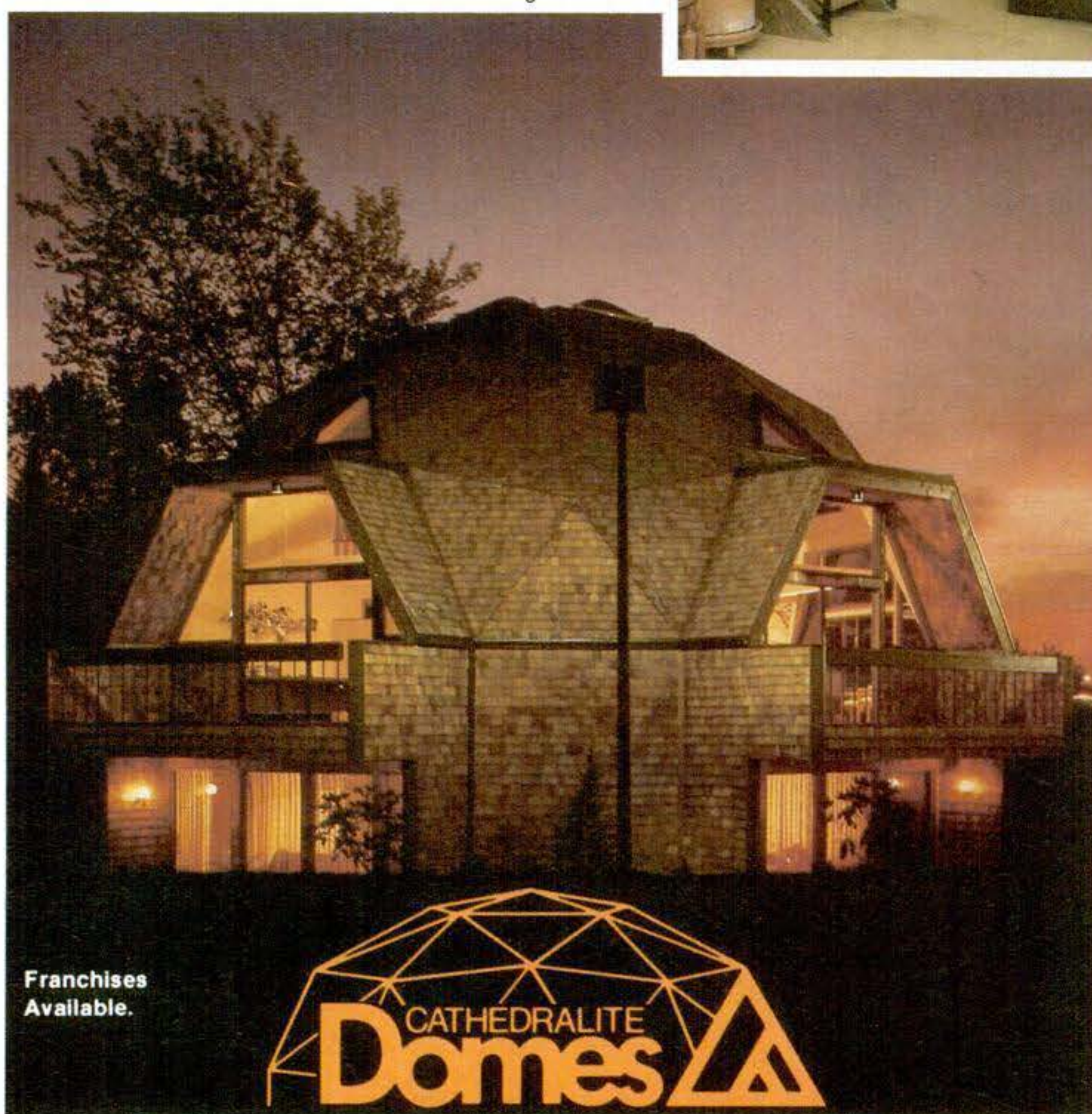
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Motorized two-wheelers

[Continued from page 67]

insurance costs increase with the size of the motorcycle.

Theft and collision insurance on motorcycles is another matter. In high-theft areas, you simply may not be able to get any. Or the cost may be prohibitive. Theft insurance for a large motorcycle may be prohibitive anyway, regardless of where you live.

Learning the basics

For non-riders, learning to ride safely is the first obstacle. There are various ways to do it. The Motorcycle Safety Foundation, a nonprofit organization funded by the five major motorcycle manufacturers, offers an excellent beginner's motorcycle riding course in many parts of the country. Motorcycles are furnished.

Usually the course is free, although occasionally a moderate fee (\$10-\$15) is charged. If your local motorcycle dealer is not familiar with MSF courses, you can write to the Motorcycle Safety Foundation (780 Elkridge Landing Rd., Linthicum, Md. 21090) to find out if and when a course is offered near you.

Some automotive driving schools also provide motorcycle driver training. Check your Yellow Pages. Looking in the Yellow Pages for the area where I live, for example, I quickly found two schools that offer motorcycle riding instruction. Some places do it with dual-control motorcycles (the instructor sits behind the rider and has a dual set of handlebars and controls that he can operate).

Most dealers who sell motorized two-wheelers will offer some riding instruction to beginners. Sometimes that instruction may be extensive. But more often it will be very basic—learning where the controls are and riding around in the parking lot until you get the feel of the machine.

More instruction than this is needed. If no formal instruction is available, at least get an experienced rider with a safe street-riding record to teach you.

For moped riding, send a stamped, self-addressed envelope to the Moped Assn. of America, 1001 Connecticut Ave. N.W., Washington, D.C. 20036, and ask for "Learn the Big 5 of Moped Safety and Pleasure." This is a fine booklet with many excellent riding and safety tips. Although aimed at moped riders, it also contains much useful information for beginning motorcycle riders.

And most importantly, whenever you ride, wear a helmet—whether or not your state has a helmet law. **PS**

Install-yourself hot tub

[Continued from page 99]

the long run to have a smaller pump circulating the water to the filter and heater. We also felt we'd like the choice of a calm flow of water from a small pump as well as the more vigorous hydrotherapy action provided by the larger pump.

For our system we selected a 1/2-hp pump for our filter and heater and a 1.5-hp pump for our jet system. One reason we chose Hayward's Super Pump is that the motor may be removed without disconnecting any plumbing; this simplifies servicing.

In looking for fittings, we realized that not all are long enough to pass through the 1 3/4-in.-thick walls of a wooden hot tub. Hayward does make them specifically for thick-walled installations. We also used Hayward ball valves and check valves. All the company's fittings are available with either threaded or socket ends suitable for plastic pipe joining.

We had decided on Schedule 40 PVC pipe because we felt it would hold up better over years of use. (Another option would have been high-pressure, high-temperature reinforced rubber hose, used with adapters.)

One fine Saturday morning we set out to put it all together. Because of the enormous weight of the filled tub (7000 lbs. in our case), we had decided it would be best to cut a hole in our above-ground deck so the weight would be supported by the ground. (If such a solution isn't feasible with your deck, you can, of course, reinforce it.) Our tub sits on three 4x6 chime joists set at a 90-degree angle to the boards making up the floor; these joists support the entire tub and let air circulate around it to prevent rot. We placed them across concrete footings set level in the ground to minimize any settling.

We began the tub assembly by fitting together the predrilled and doweled floorboards, placing them at right angles to the chime joists.

After all staves were in place, we took the first of the five iron hoops provided by the manufacturer and set it—using wire nails to hold it in place—at the lowest point, four inches from the bottom, so that it would bind the staves at floorboard level. We then placed the other hoops evenly on the tub, taking care that each lug spanned two staves. When all hoops were on, we tightened them—starting with the bottom hoop. One of us got on the inside of the tub and tapped the staves to round out the tub. As this was done, we tightened the lugs and pounded the hoops into the outside of the tub. This process was repeated several

times to insure a tight, round tub.

With careful planning, the placement of benches on the inside served to facilitate stepping in. We placed one an easy step down at about 18 inches from the top (which also makes it just the right height for a young child to sit comfortably) and the other lower, to serve as an adult seat. Both were made from 2x10 cedar cut to fit the curvature and installed with stainless-steel screws.

The hydrotherapy system—consisting of four jets—was located across from the lower bench, with one pair at the bench's height (perfect for a foot massage if you're sitting, correct for the small of the back if you're standing near it) and the other pair above them to hit higher in the back. Additionally, we installed directional heads to allow manipulation toward more of the body.

The hydrotherapy fittings located on the outside of the tub have breathing tubes to induce air into the nozzle; these must be located above water level. (Keep in mind when installing these jets that the lower they are in the tub, the more pump pressure is needed to operate them properly.) As the hydrotherapy system uses large amounts of water, we used a two-inch anti-vortex fitting and suction line to allow for an adequate supply to our 2 1/2-hp pump without creating a disturbing suction near the outlet inside the tub. We used unions on either side of the pump and ball valves on the intake and return lines to allow for easy disassembling of the pump for service without draining the tub.

The next step was to install the filter system and heater; they should be as close to the tub as possible and the heater must be six inches away from any combustible surface.

We located our outlet near the bottom of the tub to assist in removing any settled debris. The return line from the heater was located near the top of the tub with a directional fitting to facilitate circulation of water. We again used unions, at the pump and heater, to allow easy disconnection for winterizing or servicing. Ball valves were located on both the return and outlet to permit interim removal for servicing the components. P 5

FOR MORE INFORMATION

Commercial manufacturers and distributors are proliferating. For a list, write: **International Spa & Tub Institute**, Box 19531, Irvine CA 92713 or **Spa and Tub Assn.**, 1720 E. Garry Ave., Suite 235, Santa Ana CA 92705. Two sources we've checked out are **California Coopers**, Box E, San Luis Obispo CA 93406 and **Barrel Builders**, 1805 Lodi Lane, St. Helena CA 94574. For a suppliers list plus a new color booklet called "Redwood Garden Settings for Spas, Tubs, Pools," send 50¢ to **California Redwood Assn.**, 1 Lombard St., San Francisco CA 94111.

For individual components, check swimming-pool dealers, as suggested in text. For tubs alone, one source is **National Tank**, Box 7, Clackamas OR 97015.

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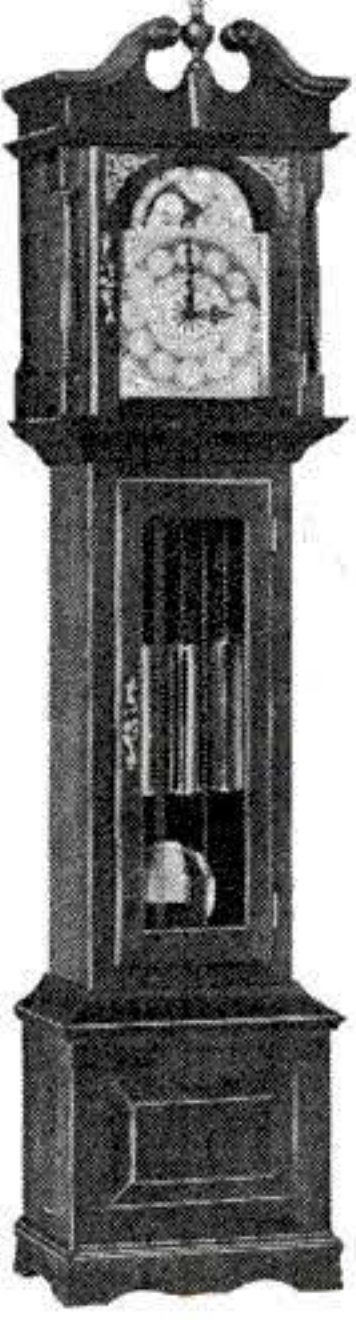
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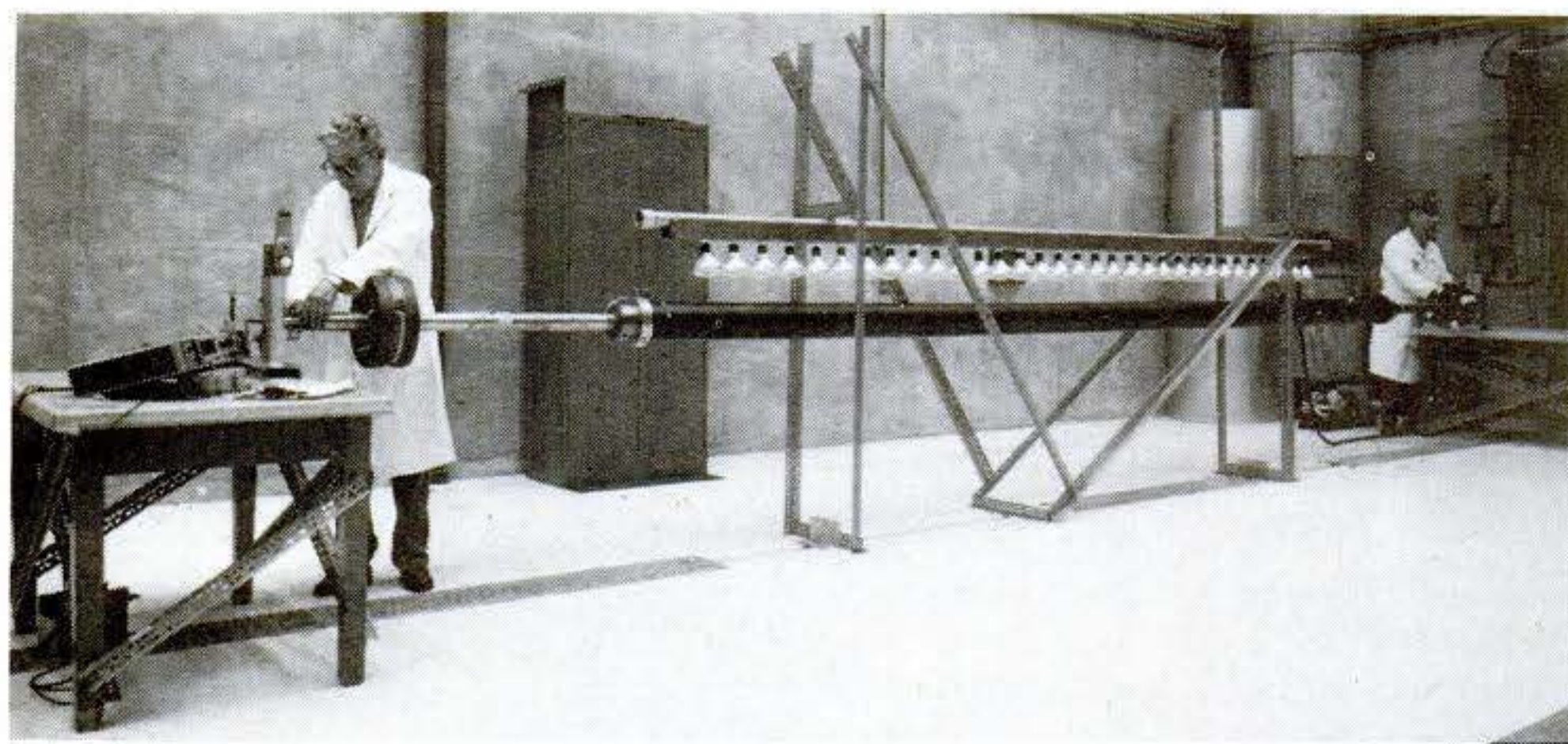
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SHOP TALK

By RICHARD STEPLER



Another solar engine

Our report on "Solar Muscle" [PS, Feb.] drew this response on a similar device. Writes reader Jim Jedlicka of Los Altos, Calif.: "In about 1970, a NASA satellite with extensible booms developed a peculiar problem: Whenever the satellite was in sunlight, its booms twisted back and forth wildly. When shaded by the Earth, they remained motionless.

"NASA's Dr. Dick Beam analyzed the

problem and proved that the manufacturer had accidentally built a crude form of solar heat engine. Beam was able to reproduce the motions in the laboratory by simulating the sun's heat with a row of heat lamps. Engineers who looked at Beam's model were so intrigued by it that they offered to work with him to devise other solar heat engines.

"The most efficient, and the simplest, turned out to be a rotary design. The engine consists of a thin-walled tube

mounted in bearings so it can rotate. A pair of flywheels is mounted on each end. Without sunlight, the flywheels droop—from sag in the tube—in a line directly below the bearings. They have no tendency to rotate in either direction. If sunlight is applied to the *side* of the tube, it expands and bends the tube sideways, toward the heat source. The flywheels are moved off center, causing them to 'fall' and rotate. Under steady sunlight, the flywheels are continuously pulled to one side and the engine turns steadily. Speed and power increase if the solar heat is applied higher on the tube. Maximum power occurs when the sun is directly on top, but then the engine isn't self-starting; so the sun is directed off the top a bit.

"The photo shows a large rotary solar engine made of a six-in.-dia., thin-wall stainless-steel tube, about 15 feet long. Two 300-lb. flywheels, burned out of one-in. steel plate, slide along steel shafting to vary the sag of the tube. Torque and rpm—to measure horsepower—are read out on the table at left. The 'sun' is the row of heat lamps.

"Free running speed of this engine was 105 rpm, but even at this speed it was an awesome sight, with the frame trembling from the somewhat unbalanced 300-lb. flywheels. The most power was developed with the engine loaded down to about half its free running speed. Shortly after the photo was taken, the laboratory director inspected the engine, said he could see no application in space, and ordered all work on it stopped."

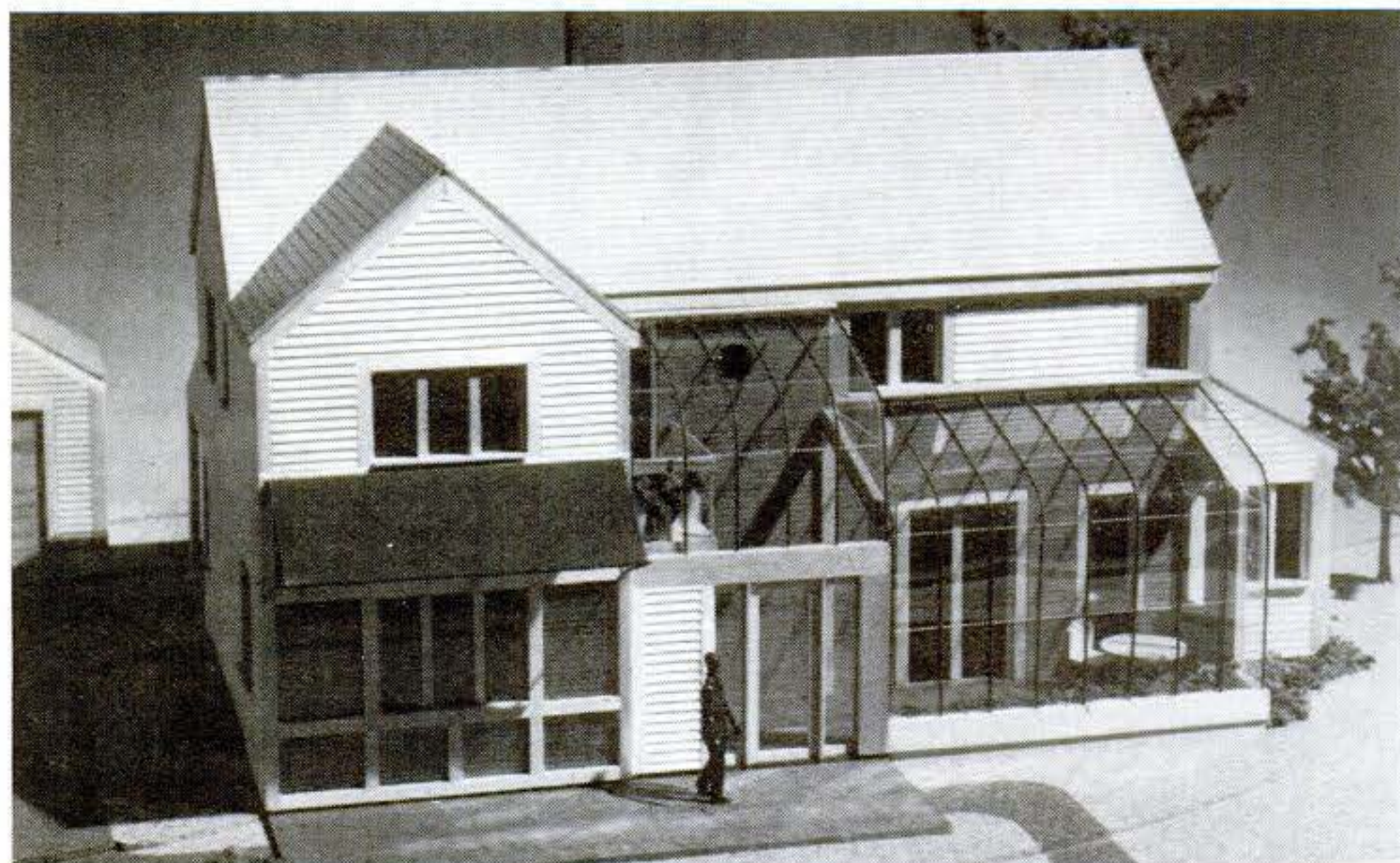
While I might have agreed with the lab director at NASA's Ames Research Center in 1970, it seems to me that now there might be some *terrestrial* applications for such a solar engine. Jedlicka adds that the final patent on the device (No. 3,830,060), covering rotary solid medium thermal-expansion engines, is held by the U.S. government.

Panning for gold

There may be a new gold rush on if items that have crossed my desk in recent weeks are any indication. "Pan Gold on Your Next Vacation" introduces you to basic equipment, the panning process, where to look for gold, and where to sell it. It's \$2.50 from Pilot Books, 347 Fifth Ave., New York, N.Y. 10016. "How to Dig for Dollars" is aimed at a range of minerals. It covers prospecting techniques, protection of claims, and government services available. From Reymont Assoc. (29 Reymont Ave., Rye, N.Y. 10580); \$2.50. And finally, there's the '49er Gold Pan, a 12-in.-dia. plastic pan with built-in cleaning "rifles" and a gold-collecting trap. From S&S Sales, 11796 Sheldon St., Sun Valley, Calif. 91352. \$2.98.

Alcohol power

Want information on the production, economics, and performance of gasohol, ethanol, and other alcohol fuels? If you don't find it in our March '80 story, "Alcohol Fuels—Can They Replace Gasoline?", call the National Alcohol Fuels Information Center at (800) 525-5555; in Colorado, (800) 332-8339. P 5



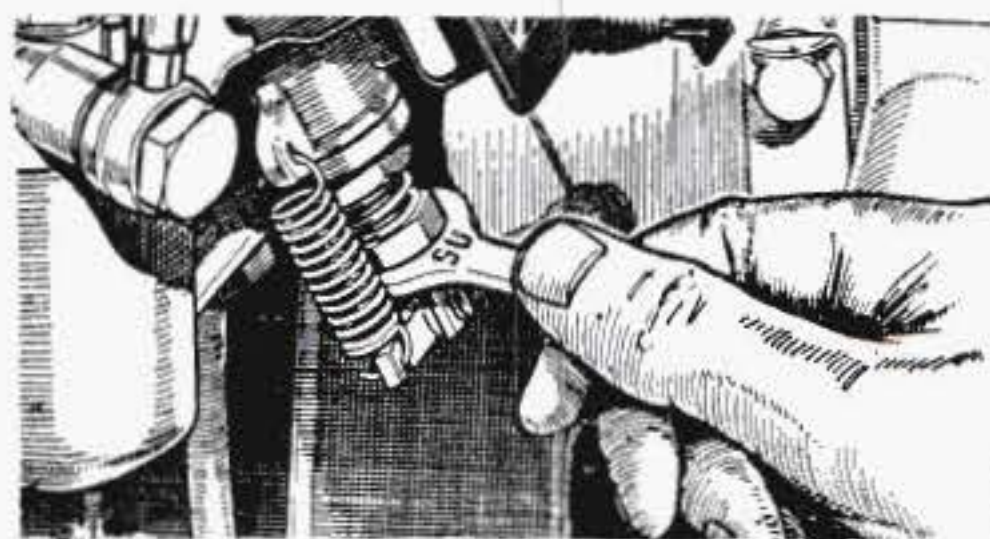
Passive-solar house

Funny, it doesn't *look* like a passive-solar house: That's a remark sure to be overheard when people get a peek at this new design for passive-solar heat gain. The Brookhaven House is the work of Total Environmental Action of Harrisville, N.H., and Brookhaven National Laboratory in Upton, N.Y.

The first such house, built on Brookhaven's grounds, demonstrates how thermal-

mass materials, such as brick, can be used to cut heating costs in an otherwise conventional-looking house. The goal of the project, reports Brookhaven, was to add thermal mass to save heating fuel without reducing comfort. That house is now being monitored.

Meanwhile, Four Seasons Solar Products Corp. (672 Sunrise Hwy., West Babylon, N.Y. 11704), suppliers of the home's greenhouse, offers its solariums for passive-solar retrofits. Write for a catalog.



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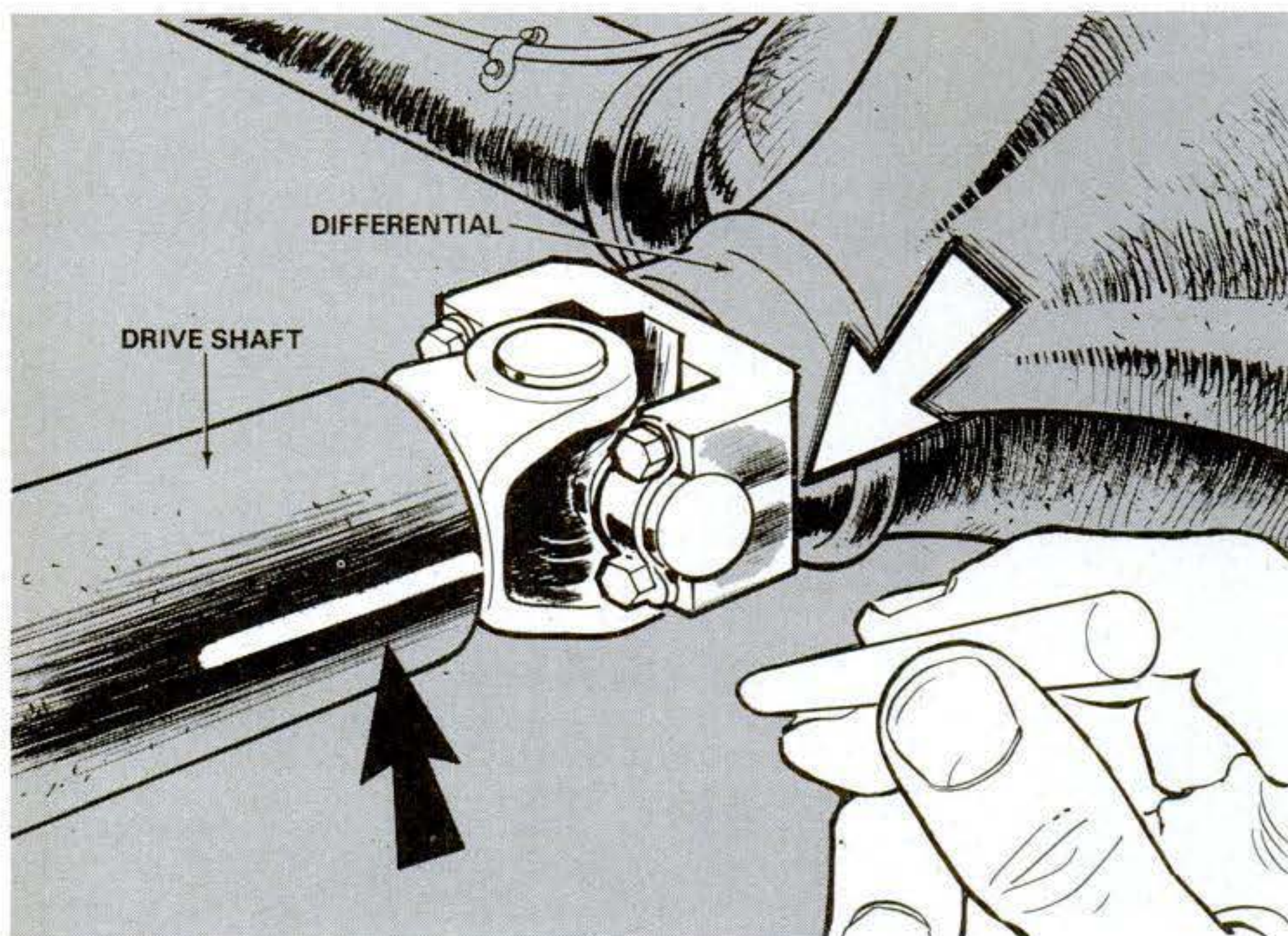
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By RAY HILL



Removing a drive shaft

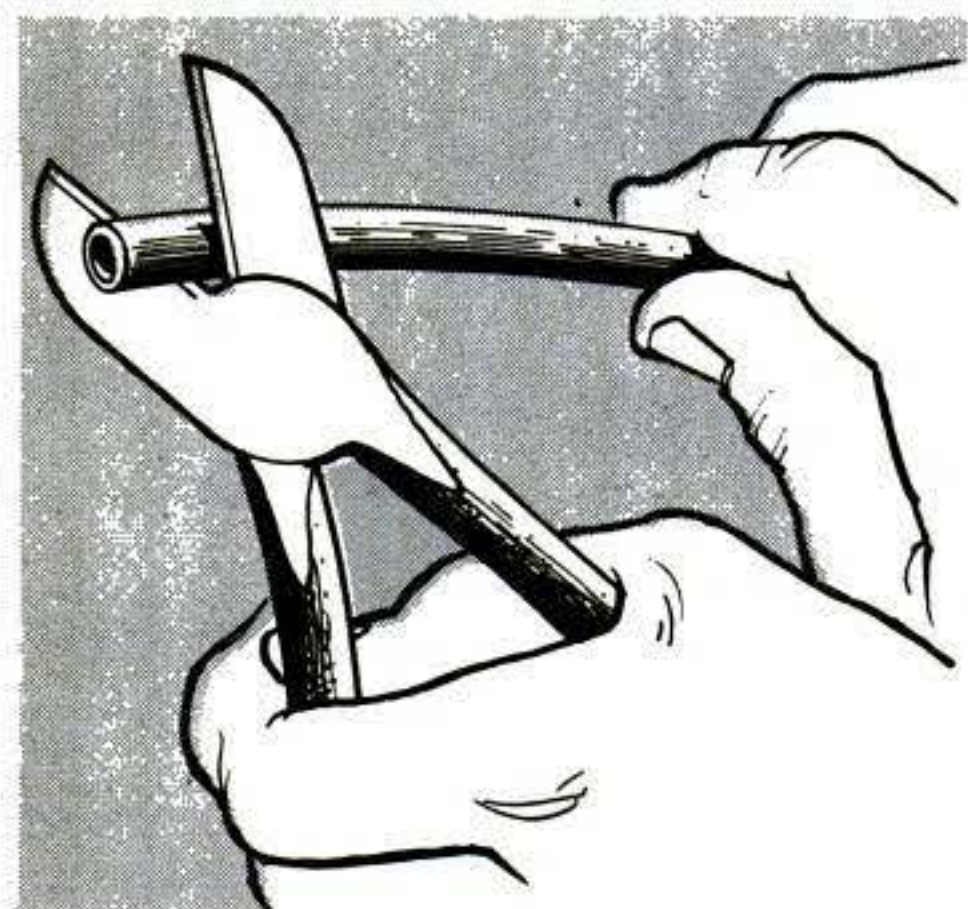
When removing a drive shaft—to replace a bad universal joint, for example—mark the differential companion flange and make a corresponding mark on the drive shaft. You *must* do this on a constant-velocity drive shaft, and it's good shop practice to do it on any propeller shaft. Drive

shafts are balanced. If the shaft was balanced while connected to the differential, reconnecting it in a different position could cause vibration when the car is driven. Marking with a scribe is best—chalk may get rubbed off. A nail may be used as a scribe if one isn't available.



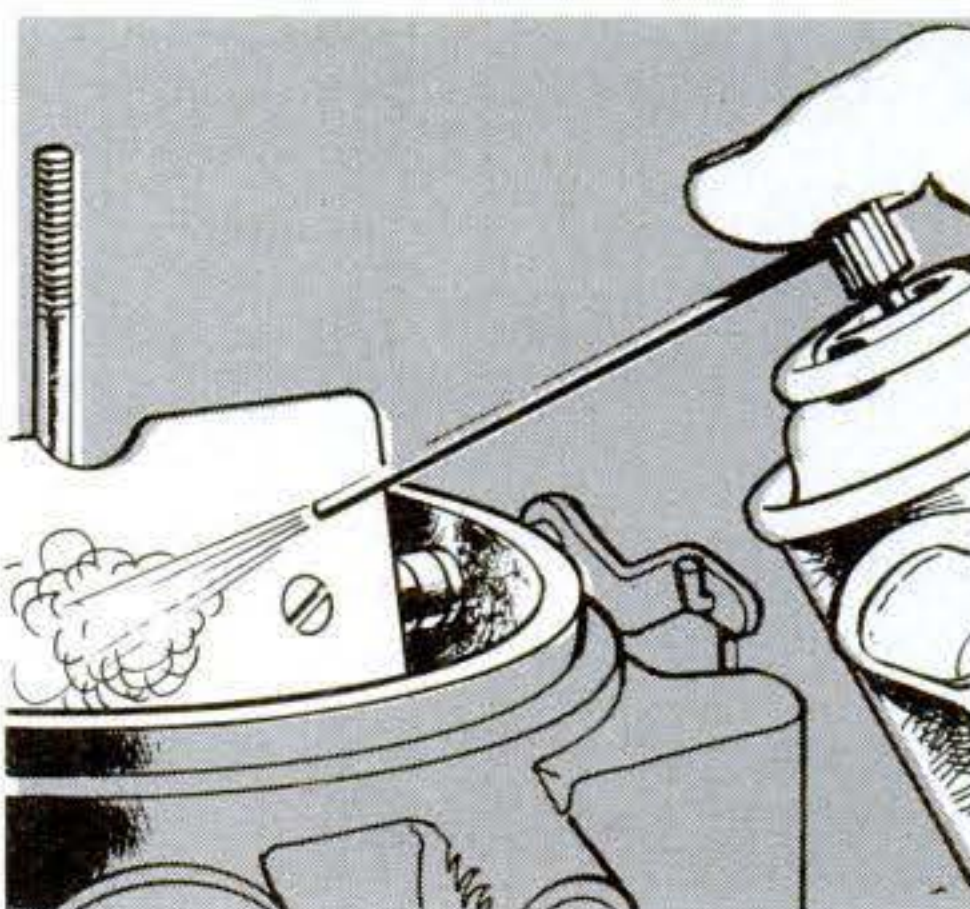
Installing pistons

When replacing a piston in a rebuilt engine, use a ring compressor and push the piston down steadily with a wooden hammer handle. The piston should slide in easily. If it doesn't, don't force it. Remove it to make sure the rings are properly compressed, then try again.



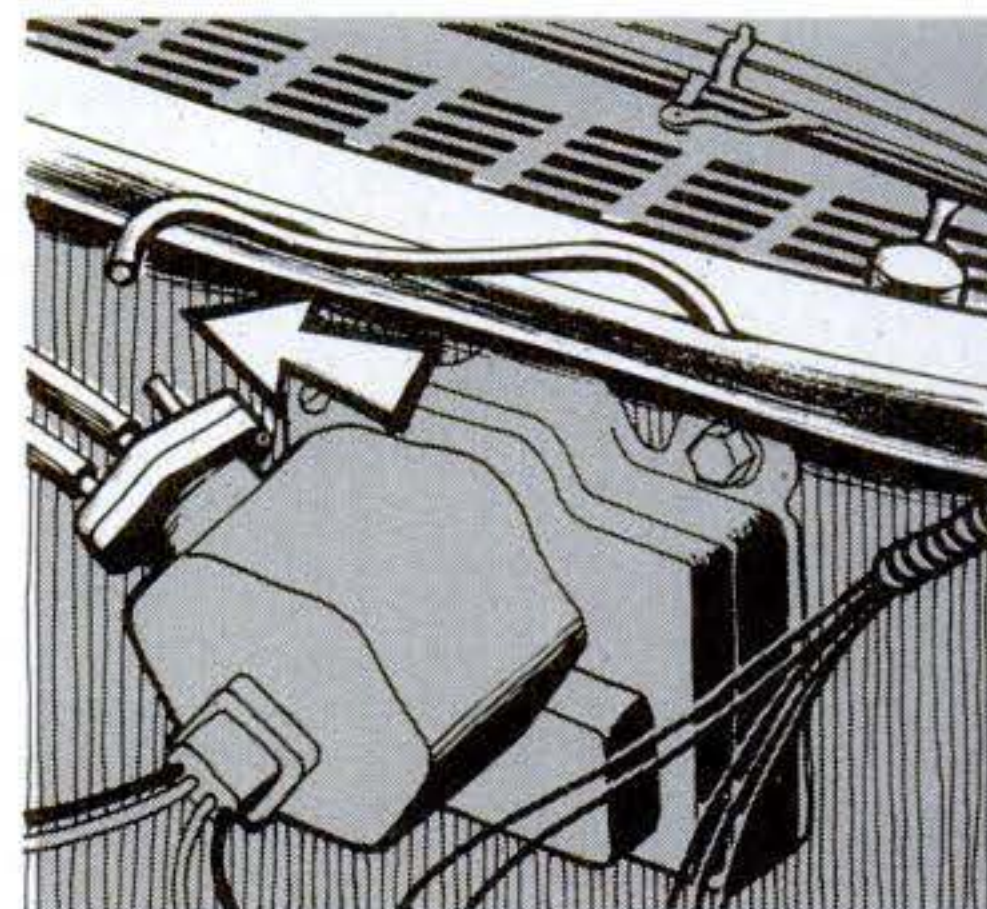
Replace vacuum hoses

As the years pass, vacuum hoses tend to harden and crack. Because of this, it's a good idea to replace all the vacuum hoses every two or three years. Measure the length of each hose with a tape measure. To make sure you get the right diameter, cut a small piece of each hose and take it with you to the auto-parts store. Most hoses just slip onto their taps. If one requires a clamp, reuse the old clamp unless it's damaged. Replace it if it is.



Rough idle?

A quick way to see if it's caused by a vacuum leak around the carburetor or intake manifold is to spray choke cleaner into the carb while the engine is idling. If the idle smooths out, isolate the leak by spraying where each intake-manifold runner connects to the head, and where the carb bolts to the manifold. When the idle smooths out, you've found the leak. Read directions to be sure spray is compatible with the catalytic converter.



Windshield washer won't spray

To find out why, remove hose from spray nozzle and turn the switch to "spray." If fluid comes out, the nozzle is clogged. No fluid? Remove the hose from the pump and turn the switch to "spray" again. If no fluid comes out of the pump, the pump is the culprit. Depending on the type, repair it or replace it. When testing, the fluid reservoir must have fluid in it, of course; and the intake hose must be in the fluid and not clogged with foreign material.

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The year was 1919, eight years before Lindbergh. Captain Albert Read and his crew of two were flying from Newfoundland to the Azores, to Lisbon, and on to England, to become the first men to cross the Atlantic by air.

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So today, when you're looking for products you have to rely on, don't forget the most important ingredient of all.

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Tough protective hardware for windows and patio doors



Charley-Bar blocks prying attack on sliding door, swings up out of way when door is opened. Long rods of **Lok-Safe** locks (in-

set) secure door by pinning through overlapping center stiles of closed doors; lock body mounts on inside door or track.

You can lock burglars out with these new devices and installation tricks

By **PAUL BOLON**

Glass presents a special problem for home security. Confronted with it, most people throw their hands up and admit defeat—after all, they say, glass can always be broken. Such lazy reasoning proves costly to homeowners every day.

Burglars don't often break glass to enter a home. They don't have to risk the noise, since most windows and glass doors can be forced easily without breakage. The butterfly latch on many double-hung windows can't resist a mild prying attack. Typical hook latches on sliding glass doors aren't much better.

If burglars can't pry open a window or sliding door, most will go no further. Police advise reinforcing your windows and sliding doors so that the only way for a burglar to gain entry is to smash the glass. If he does, and finds a keyed lock on the frame, he's prevented from releasing the latch and sliding the frame open. Instead, he must risk climbing in over jagged shards of glass still in the frame. Making him do this may not seem much of an added barrier, but police insist that these precautions stop many burglaries. (Our cover story in the May issue dealt with entry-door security.)

Making sliding doors and windows jimmy-resistant is surprisingly simple to do. Some of the methods recommended by police are not new, but they're still the best yet devised. And there are some new keyed locks available that, when used in conjunction

Continued

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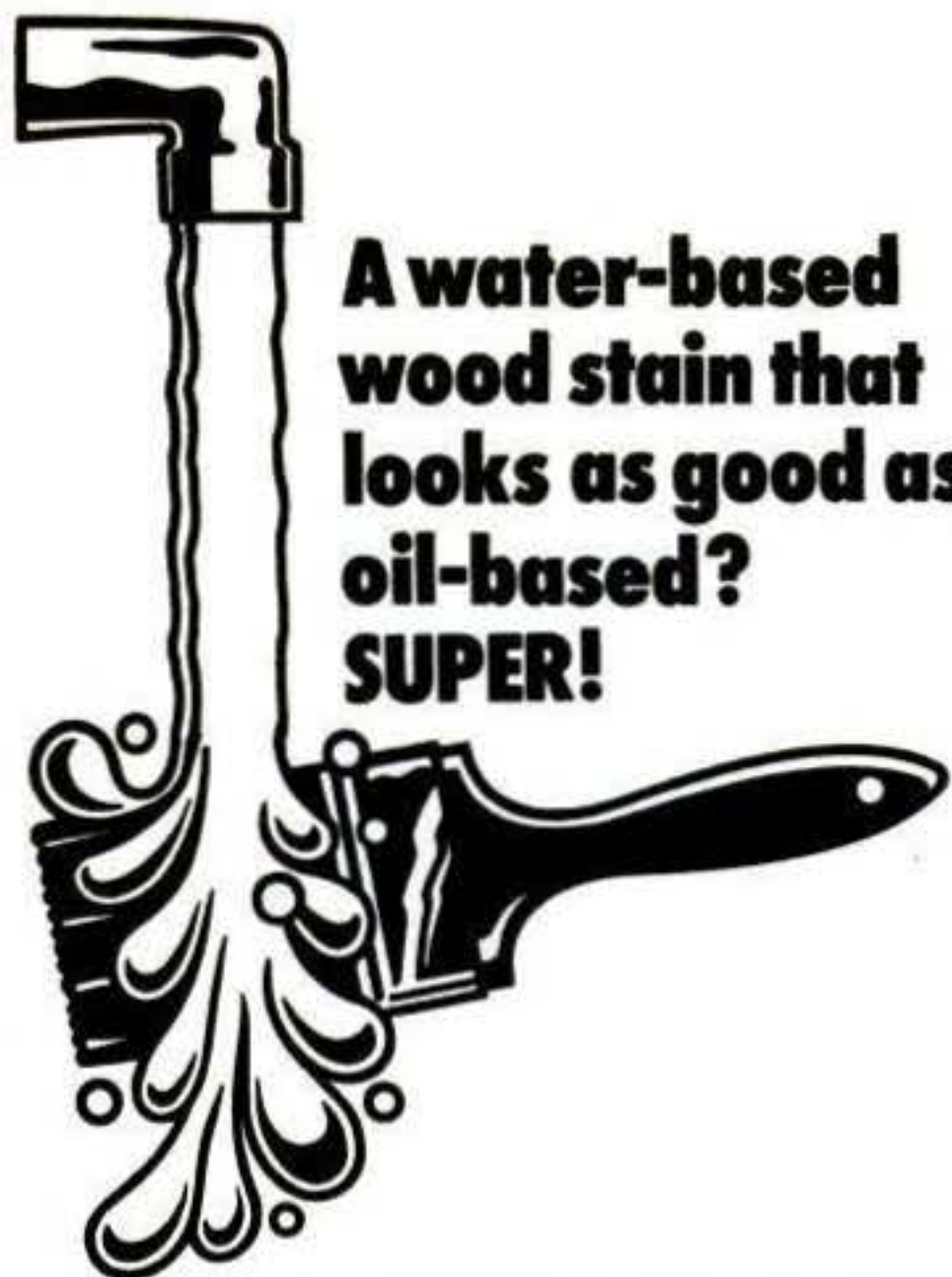
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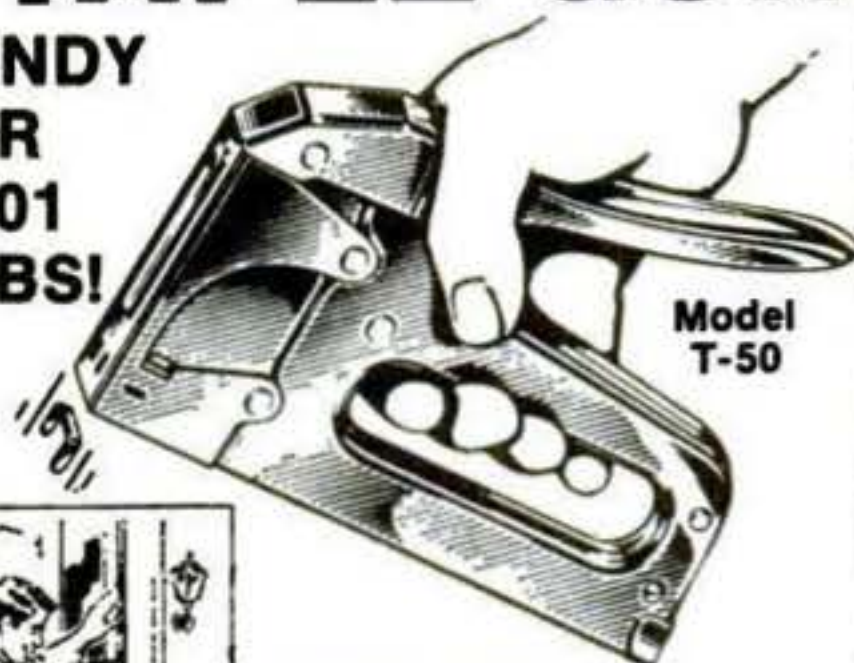


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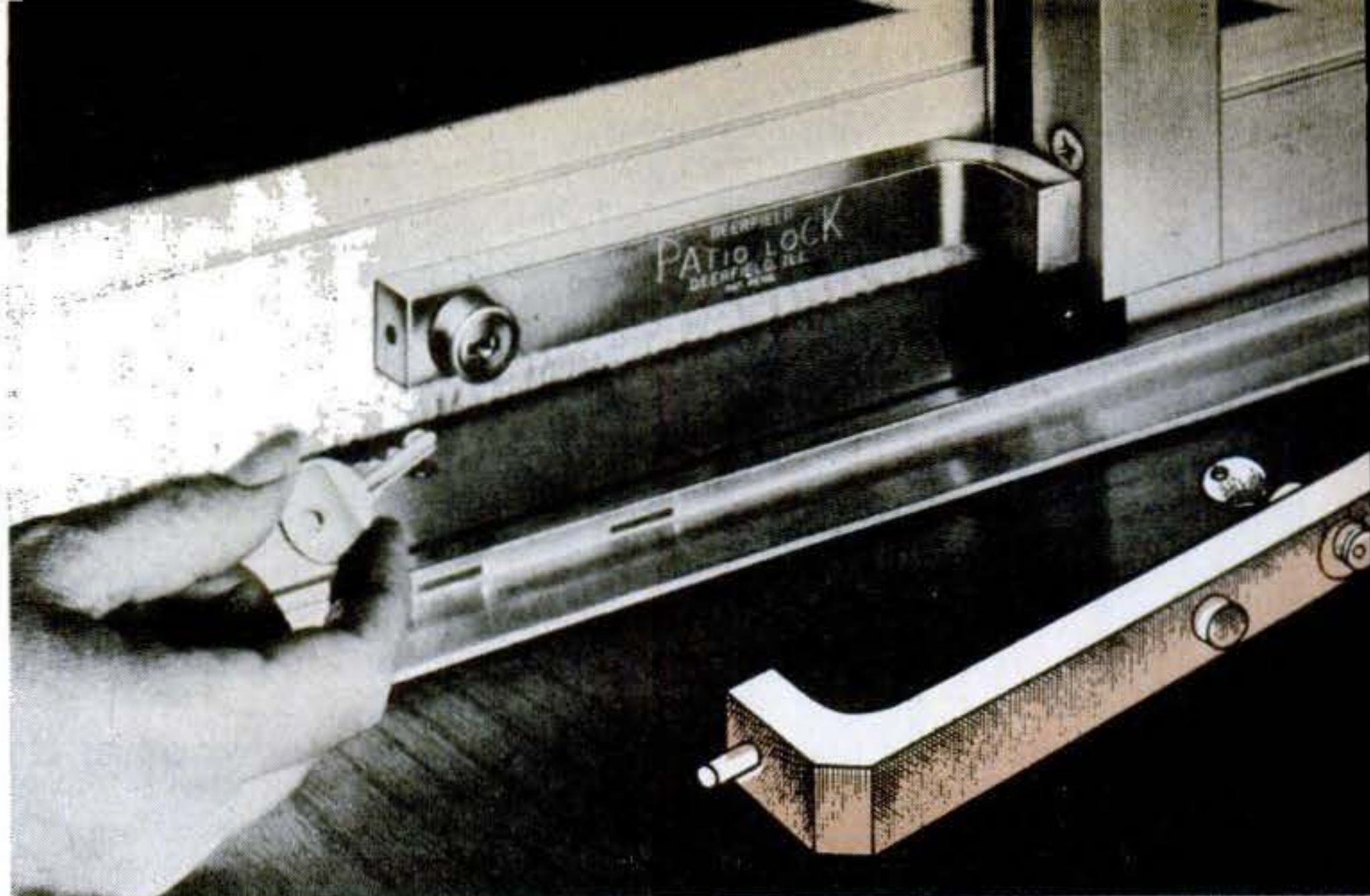


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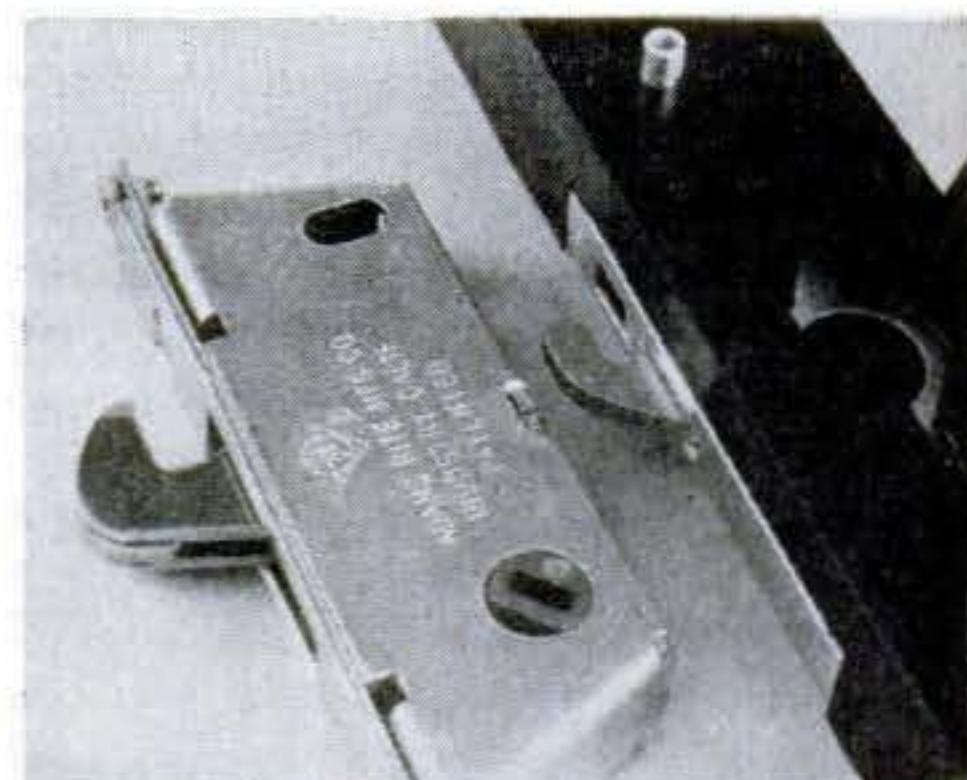


Installation of Deerfield lock requires drilling only three holes: two in fixed door

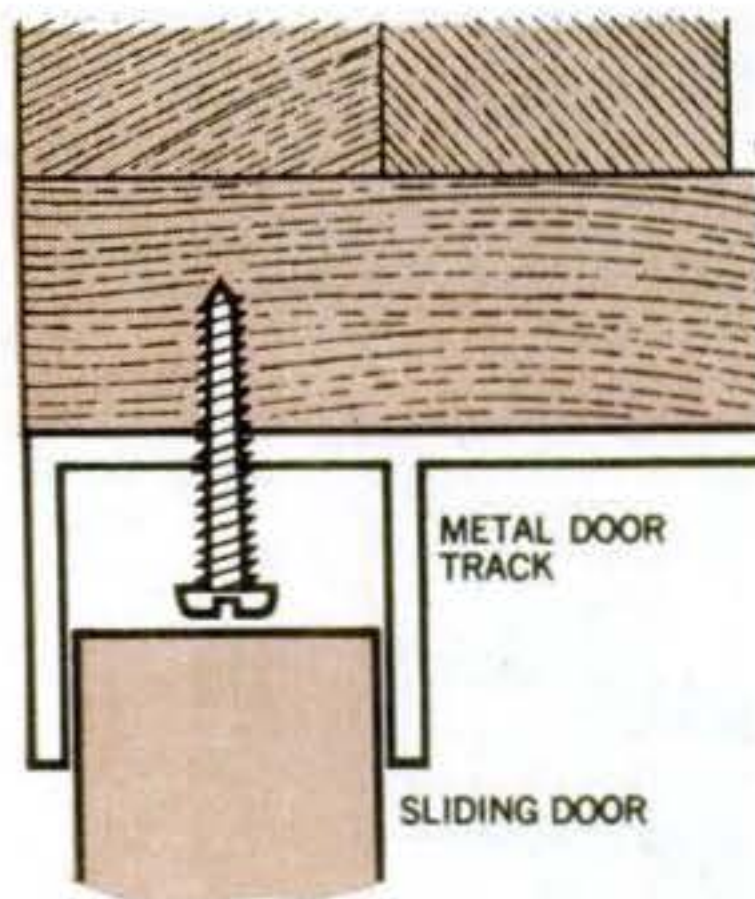
and one in sliding door. Lock body lifts off completely when door is opened.



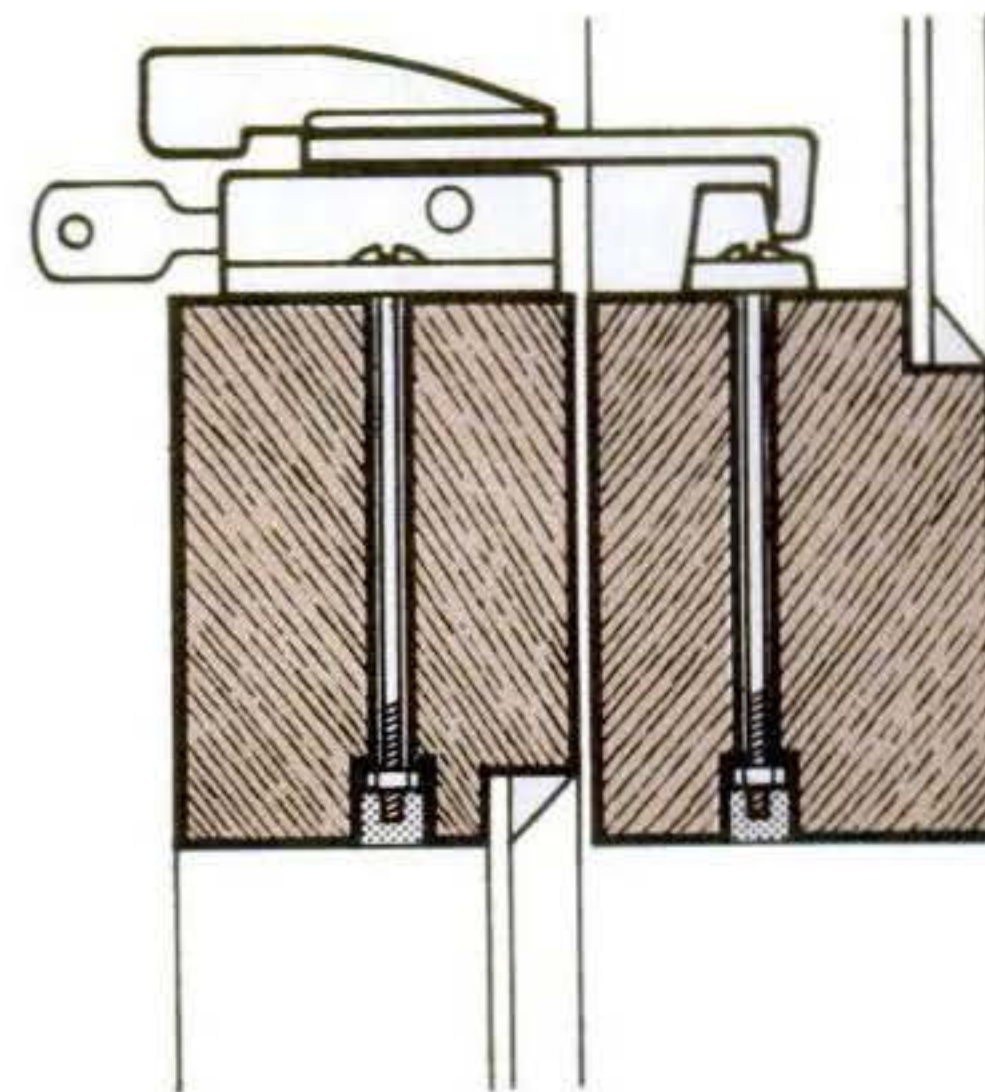
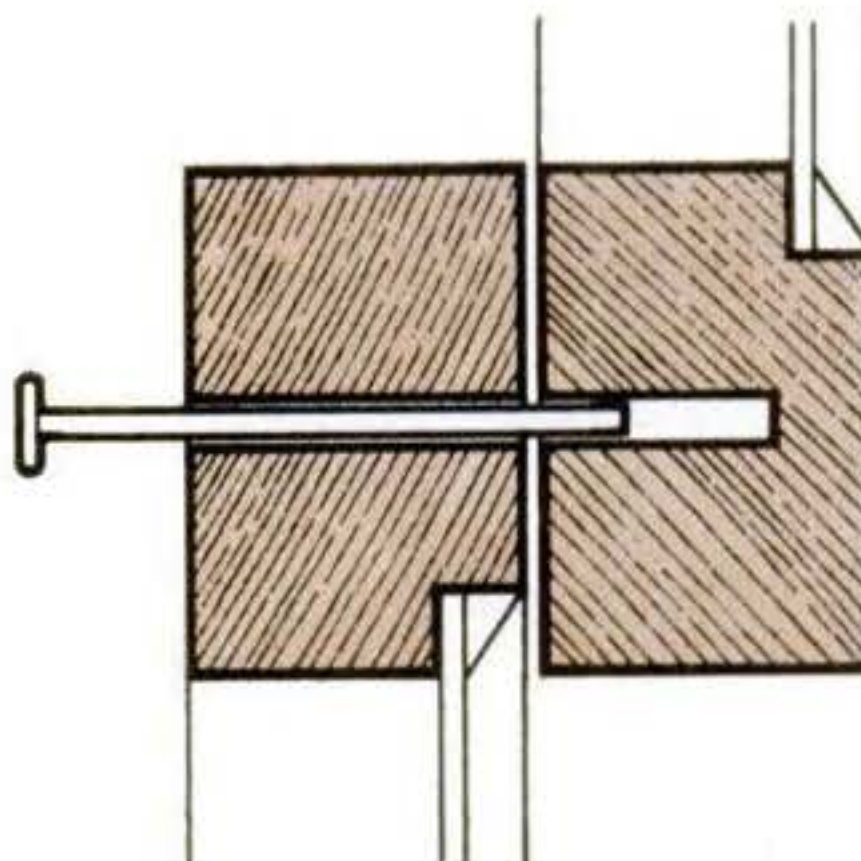
Gripping sash lock (left) resembles common butterfly (right), but is superior. Final quarter turn of handle squeezes sashes together tightly, prevents shimming.



Replacement latch made by Adams Rite (left) is several times stronger than typical latch (right), but many doors lack deep enough stile for mortise replacement.



Sheet-metal screws installed in top track of sliding door (left) prevent jimmy break-in. Windows can be protected from prying attacks by pinning sashes with 10d nails (below left). Nail heads should fit flush against sash to prevent detection. Short length of nylon fishing line tied below head aids removal. If possible, through-bolt window latches (below) with carriage bolts or, if nuts interfere with latch operation, counterbore larger holes for nuts underneath. After tightening, cover nuts with hard-drying filler.



Window and patio doors

Continued

with police anti-jimmying ideas, offer a significantly tougher barrier to burglars. Let's begin with what you can do to help your sliding doors.

Sliding doors

The small, usually surface-mounted hook latch is standard on 90 percent of sliding doors. This latch poses little obstacle to a burglar with any prying tool; however, the door itself is even easier prey. Because there is often space between the door frame and the top track, burglars can pry up one of the doors, lift it out, and set it aside intact. To thwart this most-common assault, put several sheet-metal screws into the track above both doors (see drawing). If the top rail on your aluminum frame doesn't have a flush surface to meet the heads of the screws, fill the channel with wood.

You can replace a weak latch and strike with a better one, or install an add-on lock. Don't rely on a board laid in the track behind the moving door; it can be popped out by a shim worked between the two doors. Many new doors are "hurricane" models, with the moving door in the outside track; with these, you can't use the board trick, anyway.

Several companies sell strong mortise or surface-mount locks that can replace weak latches. The mortise substitutes are inexpensive—about \$5—but they require a door stile with 1½ inches of hollow space inside.

There are three kinds of add-on locks to back up a weak latch: the Charley-Bar, stop-type locks that attach between the two doors, and pinning locks.

The Charley-Bar is a light aluminum bar that installs between the moving door and the frame (see photo). The bar fits into a catch on the back of the door and swings out of the way when the door is opened. The Charley-Bar costs \$7.75; a short extension with a keyed bolt costs \$4.95.

Pegs (or studs) of stop-type locks fit into holes drilled into each door's bottom rail, thus preventing the doors from moving. The Deerfield lock is a substantial piece of angled metal with a keyed cylinder; it costs about \$8. A lock with a similar pegging principle is made by National Lock Hardware. Each of these locks requires a rail at least 1½ inches tall for installation. If your door has rollers, be sure that drilling holes for these locks won't interfere with their operation; and don't remove any corner screws.

The third type of sliding-door lock pins the frames of the moving and

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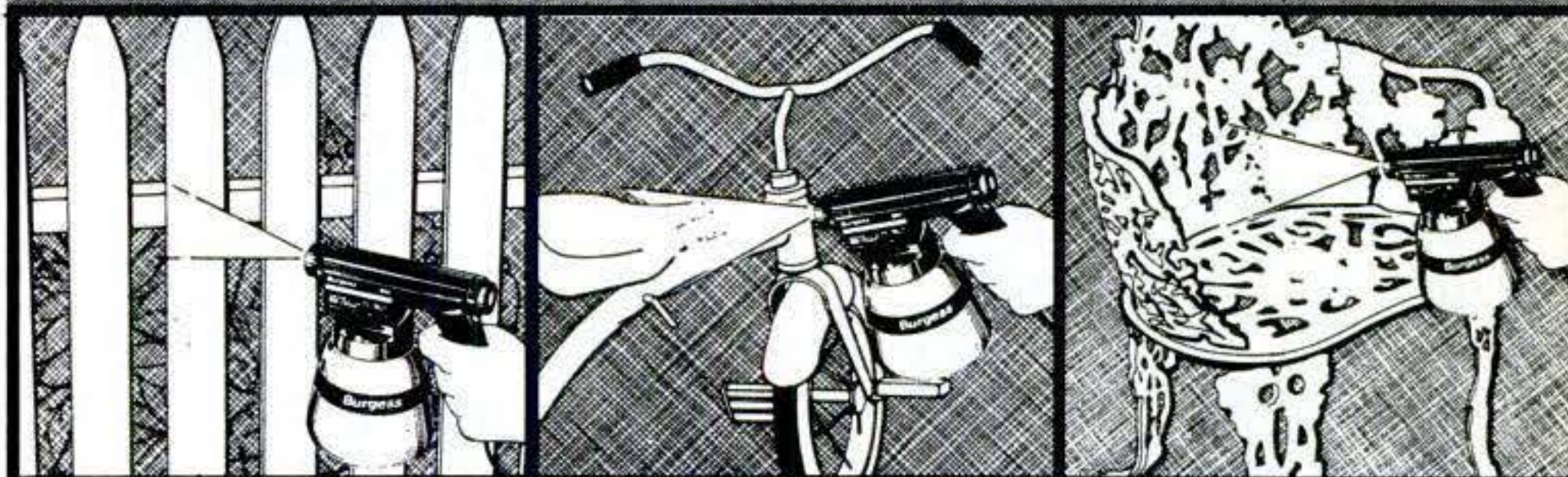
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Windows and patio doors

[Continued]

fixed doors together. With the door shut, a hole is drilled through the overlapping center stiles for a metal pin. You can make a homemade version yourself or buy a \$6 Lok-Safe pinning lock that has a key cylinder.

Windows

Standard butterfly sash locks on double-hung windows offer little resistance to prying because they are held with short wood screws. The latch can even be worked open with a thin blade inserted between the sashes. Almost none of the dime-store gimmick locks—wedges, friction-, pin- or stop-types—helps much. Police recommend the old remedy of pinning double-hung windows with 10d or heavier nails (see drawing). Drill slightly oversize holes for the nails for easy removal. Nail heads can be painted to match the window.

All ground-floor windows (and others that can be easily reached) are candidates for a keyed lock. One new sash lock works especially well with pinned windows. In the final quarter turn of its handle, it snaps shut and pulls the window frame tightly together. This gripping type of lock, made by Ideal in keyed and unkeyed versions. Lanell makes a strong pinning lock that fits flush to the sash and has a keyed lock. Cassell's unique long-pin model mortises into the window sash, and the well-concealed pin is extracted with a magnet. Replacement locking handles are made for casement windows.

Ultimate window or glass-door security is either a decorative steel grille or an accordion grate for windows on fire escapes. In high-crime areas, fire-escape and ground-floor windows need this protection. Police recommend only one type: It has a keyless lock that can only be released from the inside. Padlocks are absolutely out for any window that's a fire exit. All household members should be taught how to unlock all windows and sliding doors on fire egress routes. Keep extra keys within 40 inches of windows and doors. What about keyed locks on children's bedroom windows? The risk is probably too great.

MANUFACTURERS' ADDRESSES

Patio-door locks: Deerfield Lock, 758 Hoffman, Deerfield IL 60015; National Lock/Econo Trading, 1901 9th St., Rockford IL 61101; Charley-Bar, 333 W. 195 St., Glenwood IL 60425. **Window locks (gripping-type):** Ideal Security, 215 E. 9th, St. Paul MN 55101; (pin-type) Lanell, Box 31425, Charlotte NC 28231; Cassell Craft Co., 67 Vine Hill Rd., W. Hartford CT 06110. **Patio-door replacements:** Adams-Rite, Box 1301, 4040 S. Capitol, City Industry CA 91749; Schlegel, 1555 Jefferson Rd., Box 23197, Rochester NY 14692; W&F Mfg., 811 Airway, Glendale CA 91201. **Pinning locks for doors and windows:** Lok-Safe—All-Rite Industries, Inc., 2470 NW 15th St., Opa-Locka FL 33054. **Window grates:** Kaufman Iron Works, 1685 Boon Ave., Bronx NY 10460.

Racing proa

uses latest lightweight materials

By SUSAN RENNER-SMITH

"It's still experimental," said Rory Nugent. "But Godiva was designed for fast, safe transatlantic passages. Let the Atlantic decide."

As you read this, Nugent should be battling the Atlantic in his craft. He hopes to be the first American to win the OSTAR (Observer Singlehanded Transatlantic Race), a grueling race from England to Newport, R.I.

Godiva, an exotic marriage of Polynesian outrigger and NASA technology, has a good chance, Nugent thinks. "This boat is just so fast," he said with some awe. "It's gone 24 knots on one good burst."

Speed is intrinsic to the Polynesian proa. Cousin to the catamaran, the proa has just one long, slim hull, with an outrigger for balance. To prevent capsizing, the outrigger must be kept to leeward, so the proa can't turn to change tack, like other yachts. Instead, the skipper slackens the sails, then pulls them around and sheets them in tightly at the other end of the boat. The bow becomes the stern, and the craft sails off in the opposite direction.

This odd design means the proa must be steerable from both ends. "The Polynesians had a huge palm frond that they moved from end to end," said Nugent. "I have two retractable rudders controlled by a central tiller." Since the proa doesn't need weight to carry it through a change of tack, Nugent built it with advanced, lightweight materials. Its 36-foot-tall, aluminum-core masts, for example, are reinforced with superstrong, lightweight boron fibers. "The manufacturing process is unique," Nugent said. "We use the same giant ovens to bake these masts as were used for the Apollo moon lander."

At 1475 lbs., Godiva is the lightest of the 152 OSTAR competitors. Nugent aims to prove that his craft is also a match for the punishing seas. **E5**

Sailing "backward" (below), Rory Nugent sheets in the sails after lowering the forward rudder and raising the aft one into a centerboard-like box. A clever push-pull cable system lets him control both rudders from the main hatch. The torpedo-like flotation tube on the craft's windward side (right) protects against capsizing. Aside from its PVC foam core, the hull is made entirely of unidirectional S-glass—a superstrong fiberglass used mainly by the aerospace industry. Nugent built the boat at his Vineyard Haven, Mass., boatyard from plans by Dick Newick.



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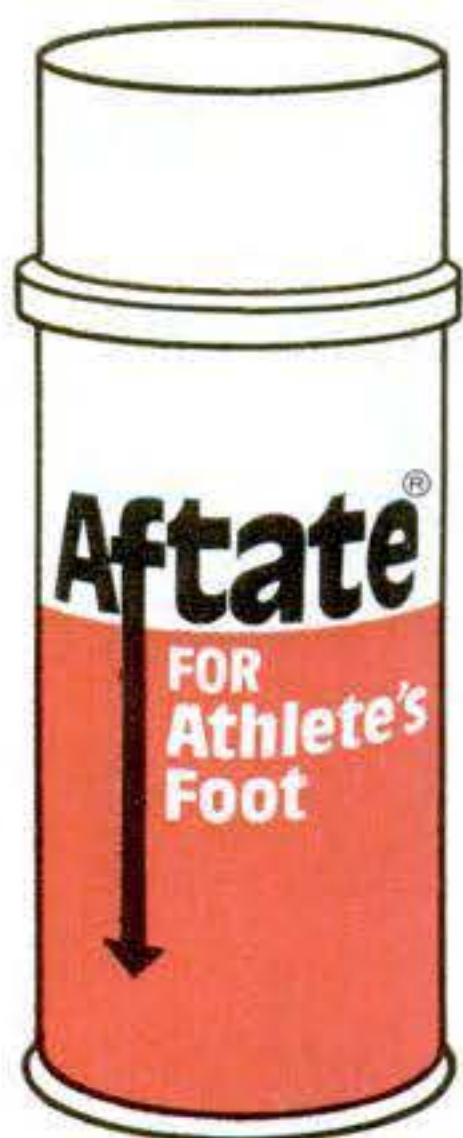
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3-D pantograph carves rough copies fast

There's a little bit of artist in all of us. All we need is a way to bring it out. One of the easiest and newest ways I know is offered by the Sears Router-Recreator. It's a special router pantograph that works in three dimensions instead of the usual two. This lets you duplicate carvings and other three-dimensional sculpture, as well as two-dimensional signs. To use it, you simply run a stylus over the work you wish to duplicate, and the router does the rest.

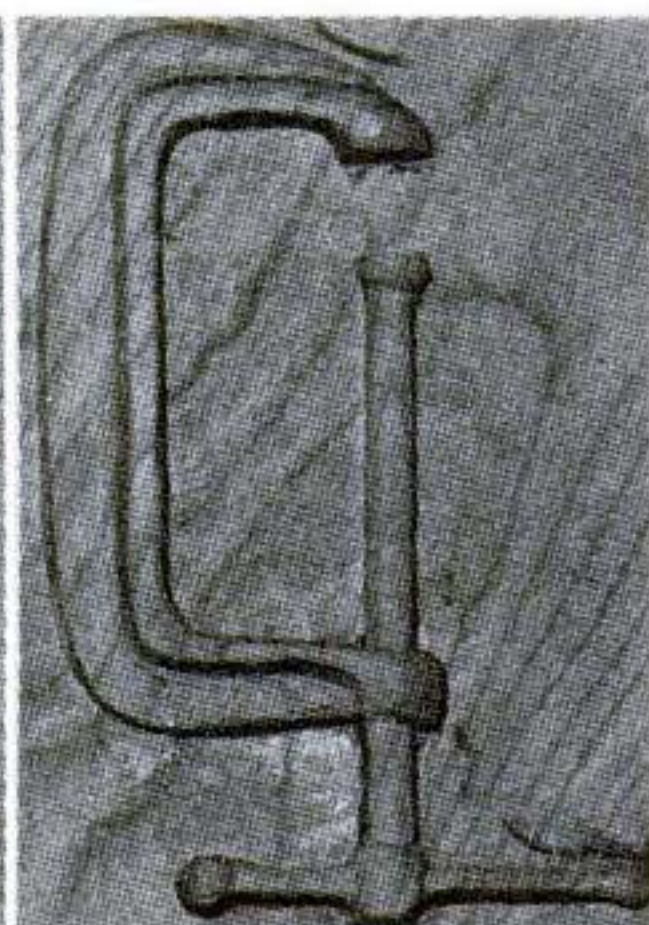
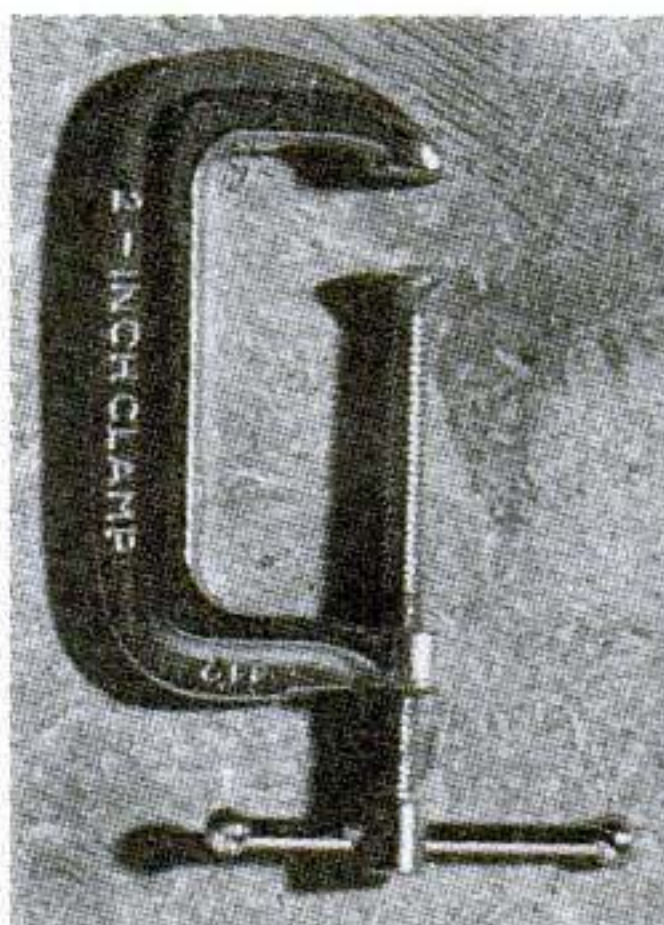
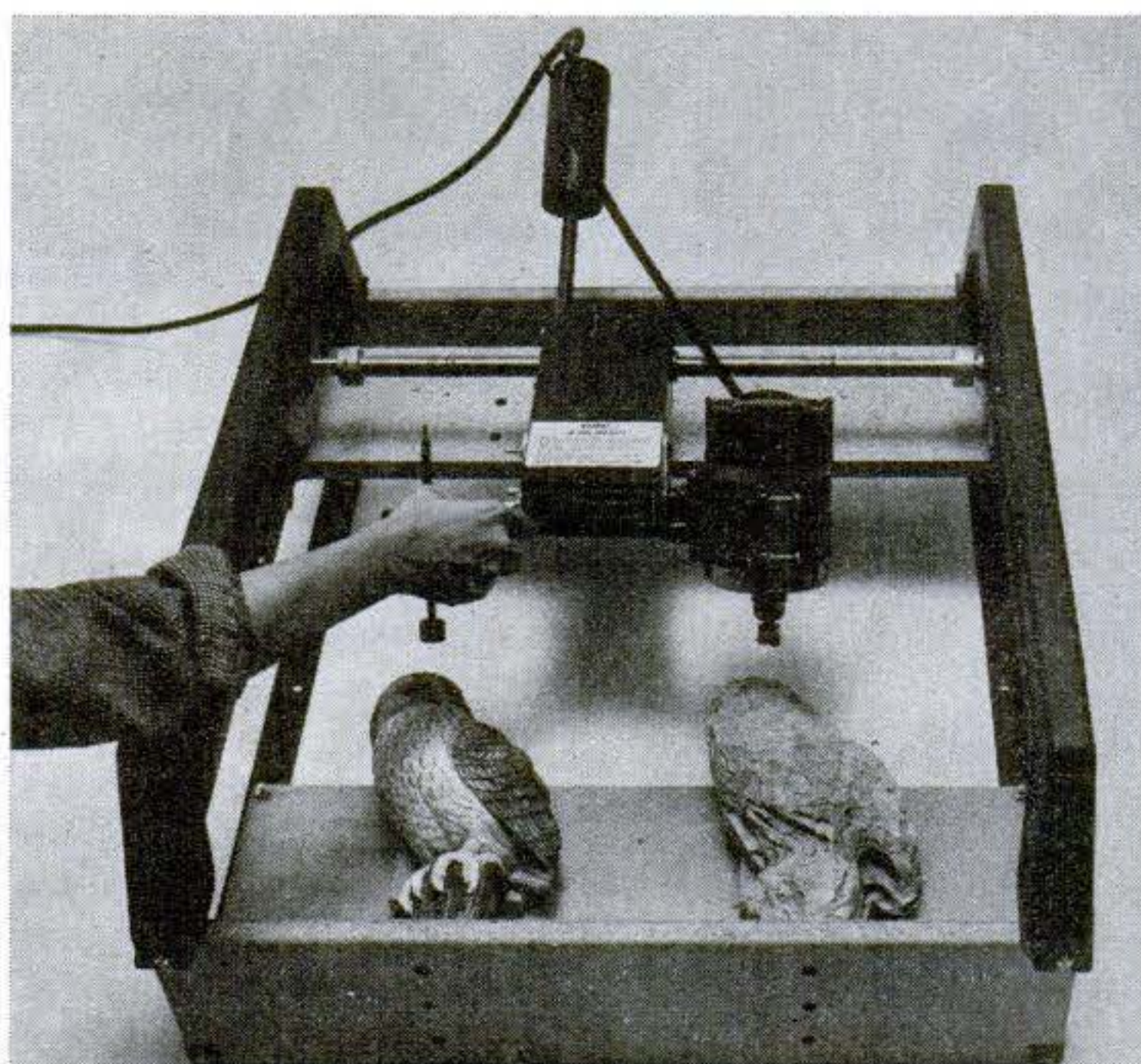
To start, cut your workpiece to rough shape with a bandsaw or coping saw. Then mount master and work-

piece on the Recreator and start routing with a 3/4-inch straight bit. About 15 minutes later you'll have the workpiece routed to a rough-cut facsimile of the original. You then work down through a succession of smaller bits and styli, adding detail as you work.

The unit is well designed and solid, with no play in the linkages; so the bits reproduce the master quite accurately. However, don't expect to duplicate fine detail. As a test I "recreated" a small C-clamp to see if I could pick up the fine detail in the lettering engraved on it. I couldn't. The Recreator is at its best duplicating bold shapes with a minimum of fine detail. It's also good for roughing out work to which you can then add details with hand tools. In fact, I liked the tool best when I used it with only the two largest bits. Once the workpiece is roughed out, you can finish it off quite quickly with rasps and sandpaper.

Hard facts: The recreator will take just about any router with a body diameter between three and 3 3/4 inches. You only have to remove the handle assembly of your router before slipping

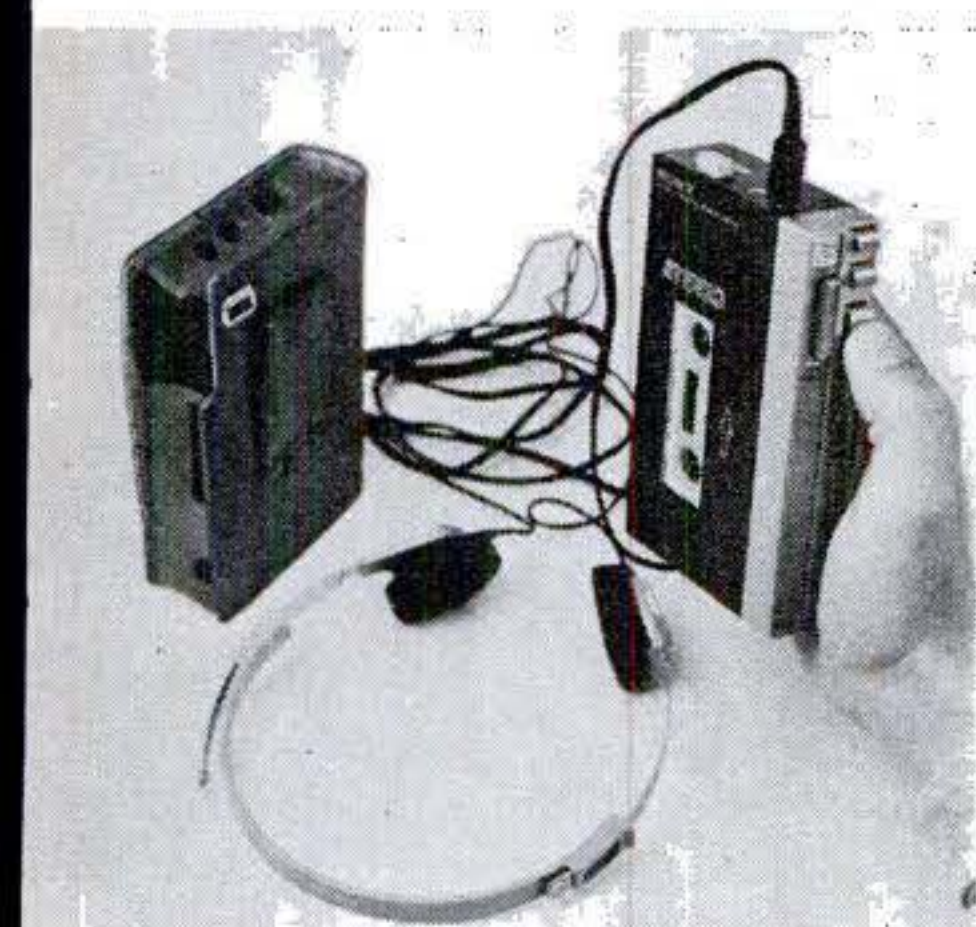
it into the pantograph's mount. The maximum work size is supposed to be an eight-inch diameter, but I cheated a bit and managed to do work a half inch larger than that. The frame takes up a lot of space, but it's lightweight and easy to take apart. The Recreator is priced at \$98.50; a set of five bits matched to the five styli lists for \$15.99.—A. J. Hand



Recreator roughed out a duplicate of the C-clamp at left in about 15 minutes. Another 15 minutes with hand tools and

sandpaper produced a finished carving (right). The Recreator also duplicates signs like the usual 2-D machine.

Big sound from a tiny stereo cassette player



Tiny tape player is only 3½ by 5½ by 1½ inches; plays regular-size cassettes.

"Wow!"
"Incredible!"
"I can't believe it!"

Every time I slip the tiny headphones of Sony's new stereo cassette player over someone's ears and turn on the music, the listener's eye widens and he exclaims with surprised pleasure. It's really hard to believe that such high-quality stereo sound can come from a ¾-pound tape player and headphones that weigh 1½ ounces.

The Sony Soundabout is designed to go wherever you go. You can commute to music via train or van pool without disturbing fellow passengers. Or take it to the library and read to music. It comes with a vinyl carrying case, shoulder strap, and a case for spare cassettes and batteries, so you can even have music in your ears while active. Imagine skiing to Stravinsky or skating to your favorite disco beat.

Much of the engineering that went into the Soundabout comes from Sony's TCM-600, the world's smallest standard-cassette tape recorder, according to the company. The TCM-600 has most of its electronics on a single integrated circuit. A coreless motor means low inertia and thus longer battery life. The tape drive uses a counter-inertial flywheel system to minimize wow and flutter.

At first glance, the Soundabout looks identical to the TCM-600. But to make room for the stereo electronics, the recording head and electronics were removed; the Soundabout is a tape *player* only. ("Who needs a recording head while bicycling?" asks

John Strom, Sony's product planner for consumer audio.) Nor does it have a speaker; you must use headphones.

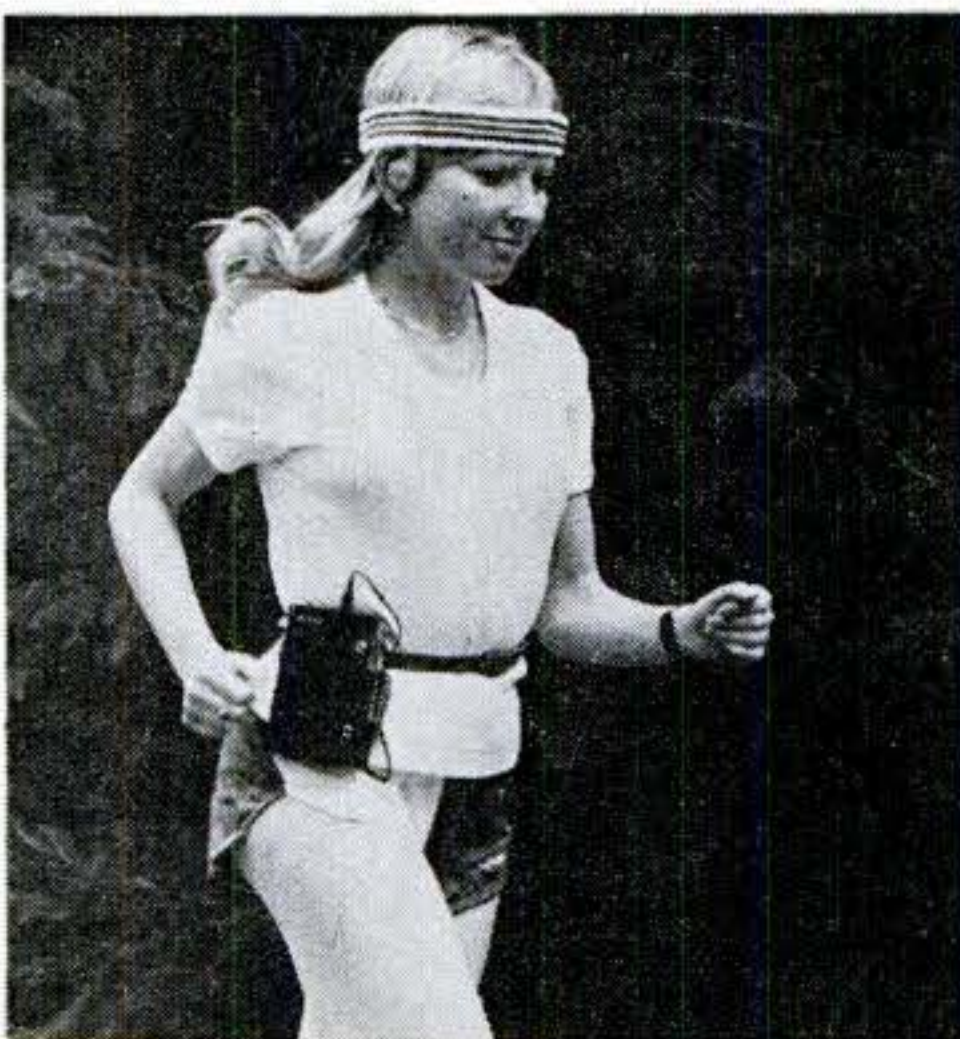
The Soundabout headphones use samarium-cobalt magnets, which are three times as powerful as conventional magnets, says Sony. That gives quicker, more accurate response to the input signals. The company also developed tiny stereo headphone jacks for the Soundabout.

The little player has separate right- and left-channel volume controls, just like large stereo systems. An orange "hot line" button actuates a microphone that lets you sing or talk over the tape. Through the earphones, it sounds as though you are the star of the performance. Other controls are conventional.

A second set of headphones can plug into the player so that two can listen together. Two AA alkaline batteries power the Soundabout for approximately eight hours. A rechargeable battery, AC adapter, and DC car-battery adapter are optional.

I found the Soundabout a delightful companion for walking and gardening, and even satisfactory for running. The first time I ran with it, I just strapped the player around my waist via the belt loop on its carrying case (see photo). But that let it flop up and down too much, causing objectionable wow and flutter. Next time out, I used the nylon sports pouch, an optional accessory that sells for \$10. With player in pouch and pouch secured to my abdomen by a strap around my neck and another around my waist, the band played on very well indeed at a moderate running pace. With faster running, a little wow and flutter returned. But running to music is certainly possible with the Soundabout. And it's small and light enough to be totally comfortable.

The Soundabout sells for \$199; an extra set of headphones is \$50.—V. Elaine Smay



Soundabout goes along, even on the run. Sweat band anchors headphones.

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Automotive trouble-shooting quiz

— match wits with the diagnostic champs

By RAY HILL

These questions are based on problems set up to test the skills of student mechanics in state and national Plymouth Trouble-Shooting Contests. Steve Mercaldo, New York automotive-mechanics instructor, whose students have been highly successful in past contests, assisted in the preparation of the problems in this quiz.

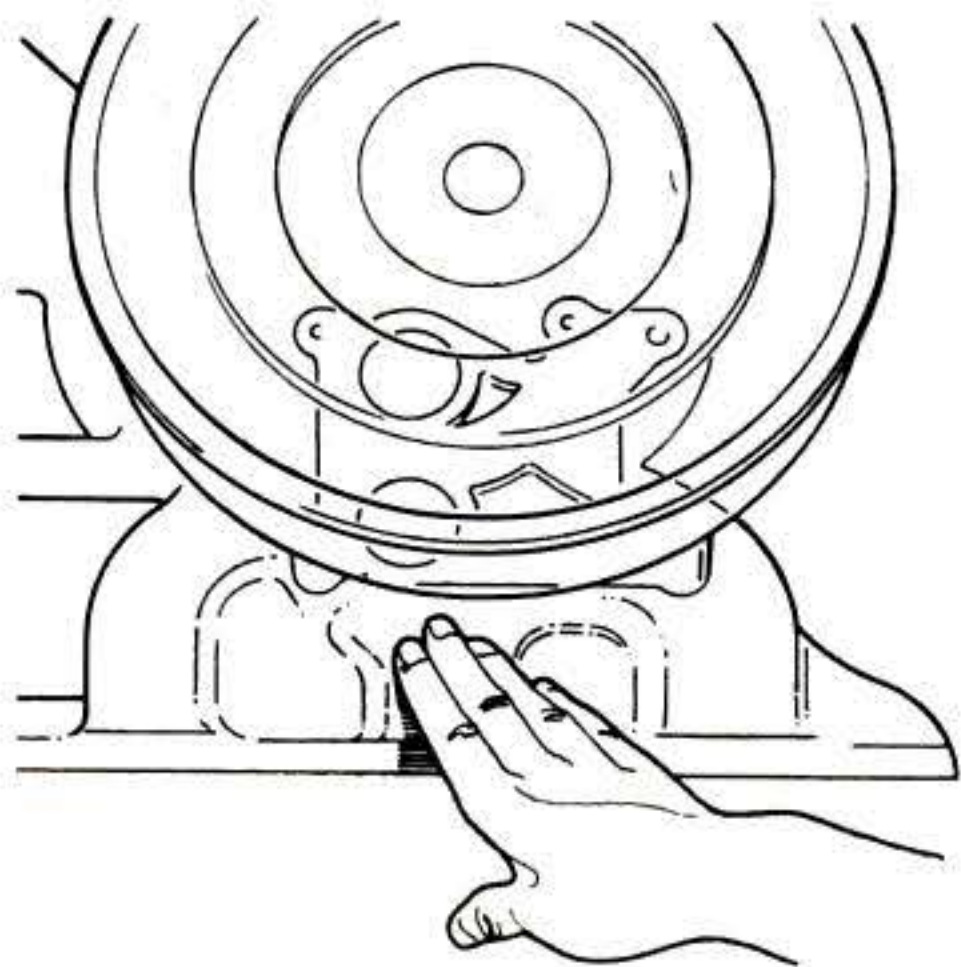
Questions

1 Poor mileage

Lately your car has been giving poor fuel economy. The car has a V8 engine, and a two-barrel carburetor that uses a well-type choke system. The choke is not electrically assisted.

Trouble-shooting the engine reveals that the choke is taking a long time to open. But the choke linkage isn't binding and the choke plate can be moved freely by hand (with the engine shut off).

The engine remains on fast idle for an excessive period of time—even af-



ter you step on the accelerator pedal and release it.

With the engine cold and not running, you can move the exhaust-manifold heat-control-valve balance weight freely by hand. Dropping the exhaust pipe and looking up inside shows the valve is moving (it's possible the weight could rotate without the valve inside actually turning).

Placing your hand on the intake-manifold crossover reveals that the crossover does not heat up until the engine has been running for over five minutes. It should get hot rapidly.

The choke pull-off is operating as it should.

Curb-idle and fast-idle rpm are at shop-manual specs.

Installing a new bimetallic choke spring and bracket doesn't help. Neither does installing a new cooling-system thermostat.

What's wrong with your car?

2 Engine idles roughly

You've noticed that your car's engine has begun to idle roughly.

Compression is within shop-manual specs.

Removing the valve covers, starting the engine, and watching the rocker arms while the engine idles reveals nothing unusual. Each rocker arm is moving up and down the same distance.

Installing new spark plugs gapped to specs doesn't help.

A visual inspection shows that the distributor cap, rotor, and spark-plug wires are in good shape.

Attaching a vacuum gauge to an intake-manifold vacuum tap gives a reading that varies between 15 and 16 inches.

A power-balance test indicates two dead cylinders. When either of those two cylinders is cancelled at idle, engine rpm doesn't change. (On Ford cars you shouldn't disconnect spark-plug wires when the engine is running. See shop-manual instructions.)

Removing the top of the air cleaner and spraying choke cleaner into the top of the carburetor causes the engine rpm to increase and the idle to smooth out.

Turning the carburetor mixture screws out to the limits of their travel doesn't make the engine idle any better. You reset the screws to their previous position.

Spraying choke cleaner around the area where the intake-manifold runners from the two dead cylinders connect to the head's intake ports causes the idle to smooth out again.

What's causing the problem?

3 Car vibrates

At normal interstate speeds your car has a noticeable and annoying vibration. A garage has checked out your wheels. They're balanced.

Tires or rims don't have excessive runout. Wheel bearings are adjusted to spec, and front-end alignment is spot-on.

There are no loose parts in the steering linkage. Nor is anything loose in the front or rear suspension systems. All the wheel lugs are tight.

Your engine accelerates smoothly. It doesn't misfire. And a power-balance test indicates each cylinder is doing an equal share of the work.

Brakes are okay. There are no bad wheel cylinders or malfunctioning

Continued

Automotive quiz

[Continued]

brake shoes or brake hardware. The brake drums are not out of round. And the front-brake rotors don't have excessive runout or excessive variation in thickness.

The vibration, which is accompanied by noise, is more noticeable during acceleration than during cruise speeds. When you decelerate, the noise and vibration almost disappear.

Whenever you shift from neutral to reverse there is a clunking noise.

What's wrong?

4 Car pulls to the left

Your car has disc brakes in front and drum brakes in the rear, as is common with most cars now. Recently, whenever you brake, either to slow down or stop, the car pulls sharply to the left.

You check tire pressures. All four tires are inflated to specs, and they're all the same brand and size.

A complete front-end inspection indicates that all parts are good and working properly. Front-end alignment is at spec.

An inspection of the rear brake system reveals no excessive dust or dirt on the drums or linings. Backing plates are secure and not worn.

Measuring the thickness of the brake-shoe linings shows them to be within the maker's specs. There are no unusual wear patterns on the linings, nor are they soaked with grease or brake fluid.

The rear-brake drums show no cracks, hard spots, or unusual wear. When measured with a micrometer, brake-drum dimensions are within specs.

The rest of the rear brake hardware checks out okay, too.

Readjusting the rear brakes to spec does not solve the problem.

Next, you check the front brakes. The right-front brake pads are not worn as much as the pads from the left front brake.

Neither brake rotor has excessive runout or too much thickness variation. Thickness is within spec.

What's causing the car to pull to one side?

5 Banging noise

Your car has an automatic transmission. Whenever you accelerate, a banging noise comes from the engine.

With the engine off and the car safely elevated, you rock the drive shaft

clockwise and counterclockwise with your hands. There is no play in the universal joints. The fasteners that hold the universal joints to their flanges are tight, and nothing appears misaligned.

You remove the torque-converter inspection plate, and with a torque wrench check the bolts that hold the converter to the flex plate. Each bolt is tightened to spec.

The power-steering pump and the alternator are both attached securely. The same goes for the battery hold-down.

The front suspension parts (control arms, shock absorbers, strut rods, ball joints, springs, etc.) are all in good condition.

The transmission mount and cross-member are okay. Using a pry bar, you cannot move the transmission or cross-member. Mounting bolts are tight, and neither transmission mount nor cross-member is cracked.

An inspection of the transmission bell housing bolts shows that they are tight. There are no cracks or breaks in the bell housing.

You notice a couple of unusual things, though. The tips of the cooling-fan blades have been making contact with the fan shroud. And during acceleration the transmission shift lever moves a considerable amount.

What's causing the banging noise during acceleration?

6 Grinding noise

Your car has a manual-shift transmission. Whenever the engine is running and the gear-shift lever is in neutral, there's a grinding noise coming from the transmission/clutch area. When the clutch pedal is depressed, the noise disappears. As soon as you release the pedal, the noise starts.

Changing the transmission oil does not solve the problem.

When you check clutch-pedal free play, it's adjusted to spec.

All rotating components on the engine (alternator, water pump, etc.) check out okay. The noise is not coming from the engine.

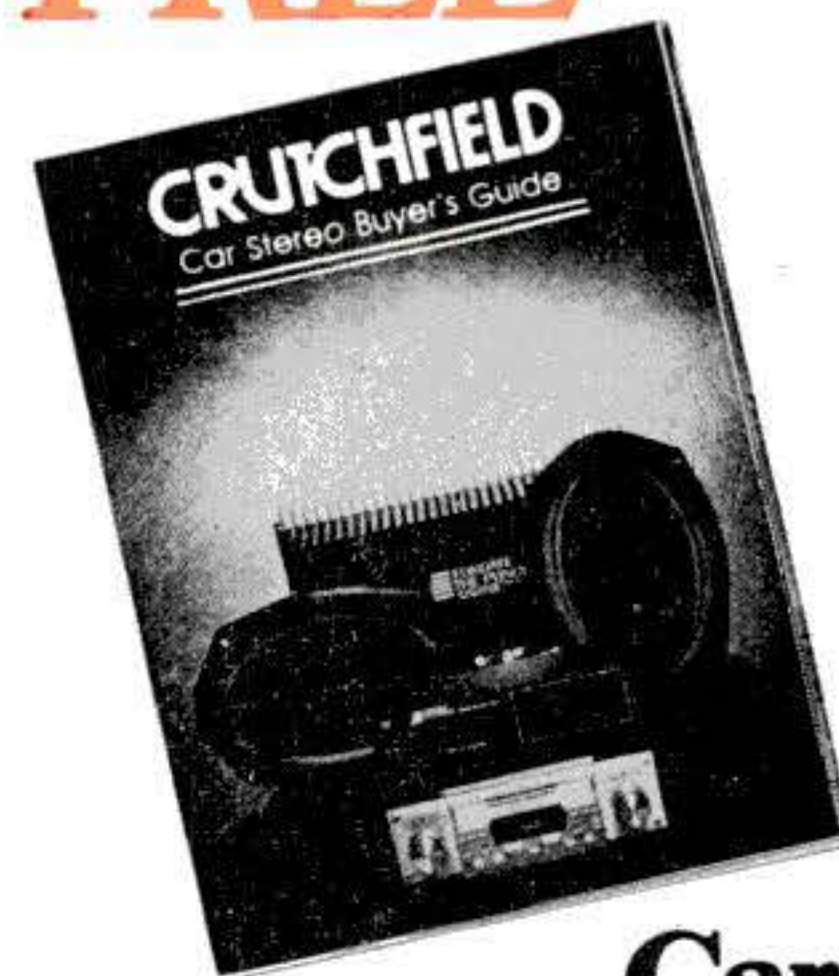
Is the noise coming from the clutch throwout bearing or from the transmission?

Answers

1 A clogged exhaust crossover is the problem. The intake manifold

Continued

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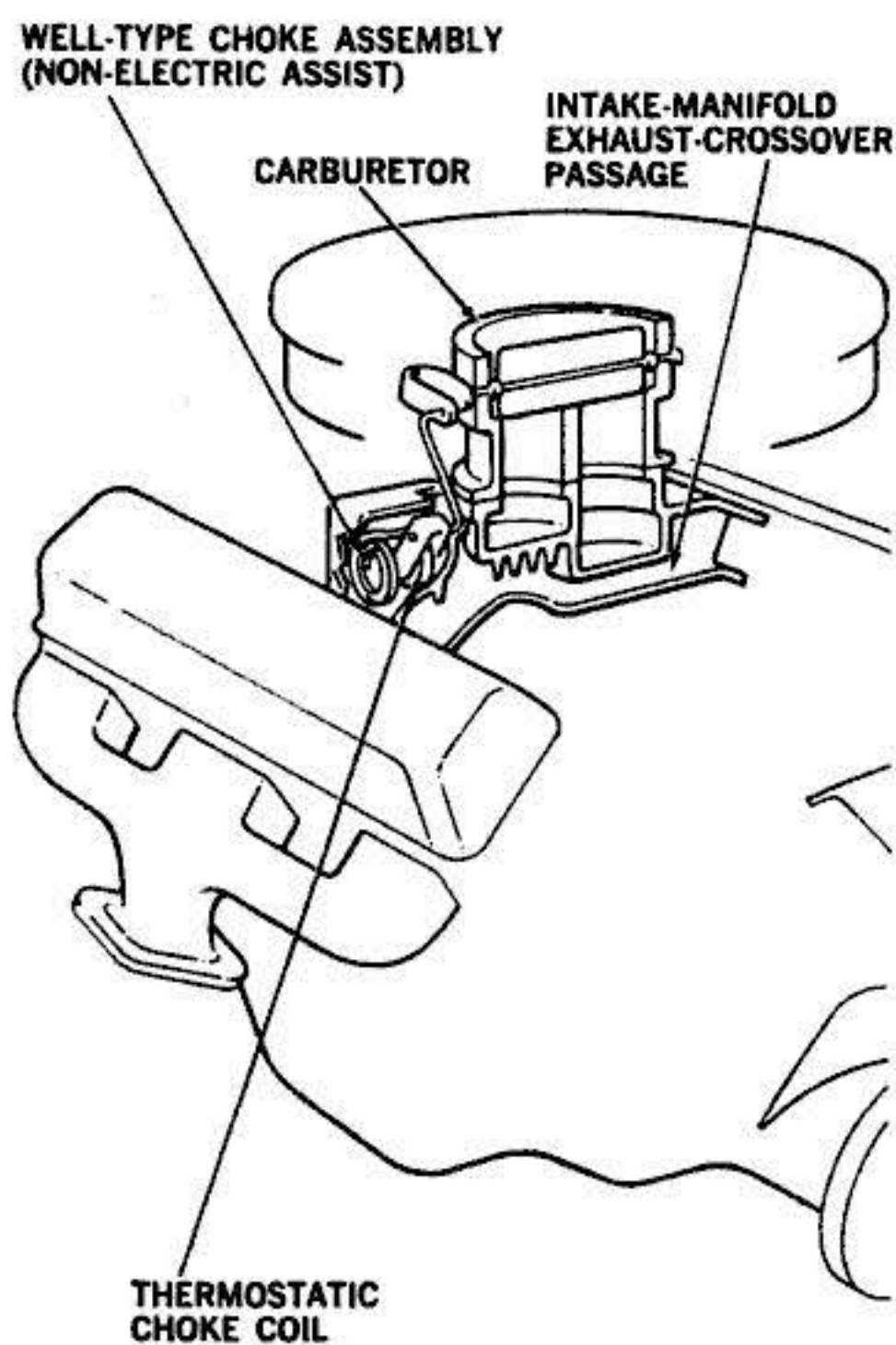
must be removed, and the carbon deposits in the crossover scraped off with a suitable tool. Using solvent won't help.

The tipoff: The exhaust crossover took more than five minutes to warm up. With a cold engine that's working properly, the crossover will become too hot to touch within a minute.

The crossover is a passage in the intake manifold that runs from one exhaust manifold to the other. It passes beneath the carburetor, and exhaust gases pass through it at startup when the engine is cold. This heat provides better vaporization of the incoming cold fuel.

As the engine gradually reaches operating temperature, the exhaust-manifold heat-control valve opens. This directs exhaust gas out the exhaust pipe (instead of through the intake manifold and then out the exhaust pipe), because the heat from exhaust gases is no longer needed to help vaporize the fuel.

In this problem, the exhaust-manifold heat-control valve is moving freely, so you know the exhaust gases



should be passing through the crossover. The fact that the crossover doesn't heat up quickly indicates it's clogged.

If the heat-control valve had been stuck, it could have caused poor fuel economy, too. For example, if it will not close to allow exhaust gases to pass through the crossover during cold starts, you'll get the same effect as a clogged crossover. That's why the valve should be checked occasionally to make sure it's moving freely.

If it's stuck, apply liberal doses of

penetrating oil to each end of the shaft that the valve pivots on, and tap each end with a hammer until you can rotate the valve freely by hand (by rotating its balance weight). Don't strike the weight with a hammer—you may bend the shaft if you do. Tap only the ends of the shaft.

In some cases, it may be impossible to free the valve by lubricating and tapping, and more severe measures are necessary.

Some manifold heat-control valves are in the exhaust manifold. With these you have to remove the exhaust manifold. Now, with the manifold off, you can get at the valve itself. Apply liberal amounts of penetrating oil and try to turn the valve with your fingers. If the valve is recessed so that you can't reach it, use a punch to tap the valve. If this doesn't free the valve, you'll have to replace the manifold (or only the valve, if it isn't integral to the manifold).

On some cars, the valve is located between the exhaust manifold and the exhaust pipe. In this case you would drop the exhaust pipe and remove the valve. If the valve still can't be freed by hand, you must replace it.

2 There's an air leak where the intake-manifold runners from the two dead cylinders connect to the head. The leak may be caused by a loose manifold, bad gasket, or cracked manifold—but it must be eliminated for the engine to perform properly.

A lot of things could cause a rough idle. But compression is good. And inspecting the rocker arms while the engine is idling shows that they are moving up and down the same amount. (If one was moving very little or not at all, that would mean a valve wasn't working—worn cam lobe, bad lifter, etc.—which could cause a rough idle.)

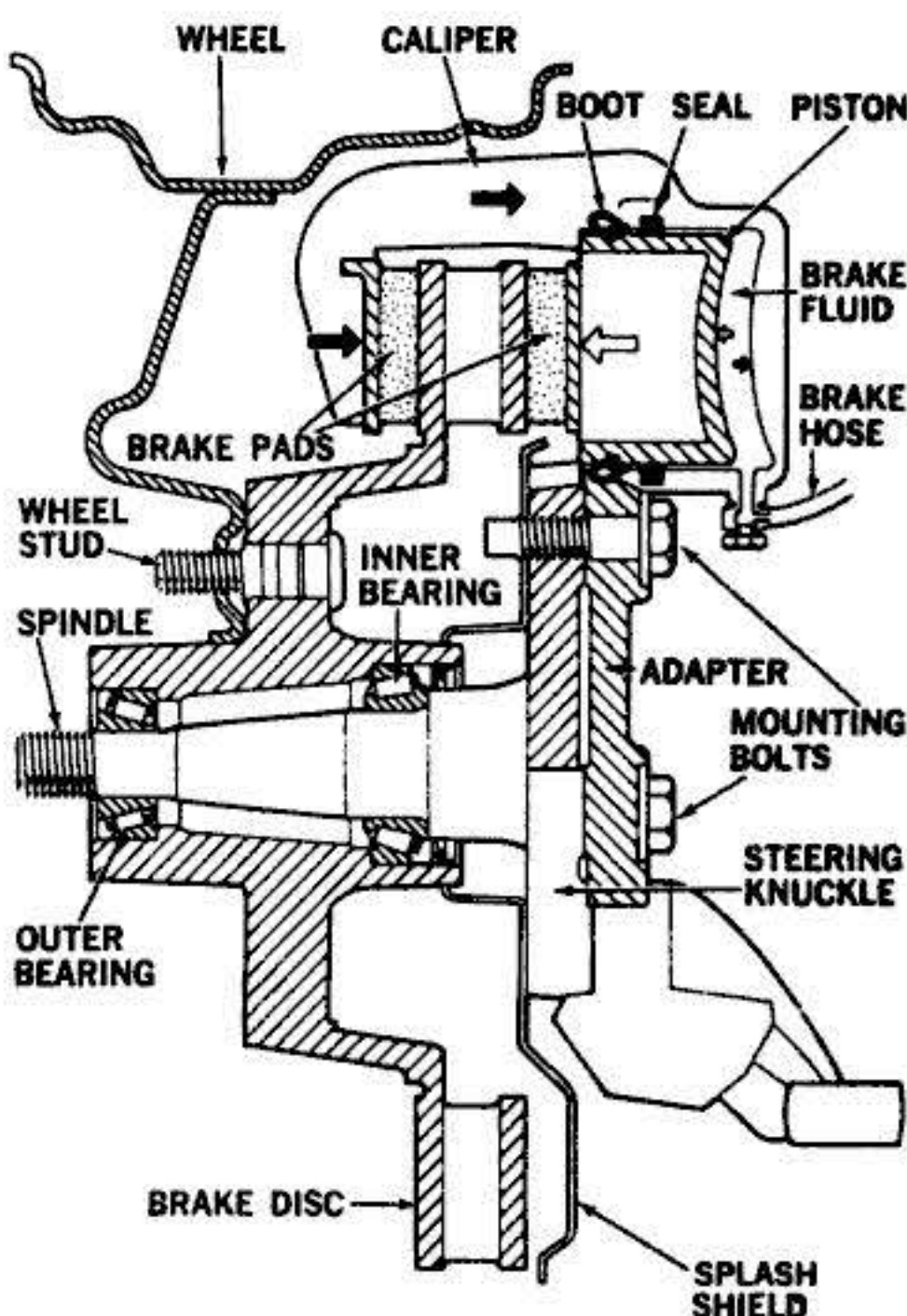
A couple of things locate the problem for you. Spraying choke cleaner in the carb while the engine is idling makes the idle smooth out. That indicates a lean condition, because spraying a combustible substance in the carb enriches the fuel/air mixture.

Spraying the carburetor cleaner around the two dead cylinders' intake runners (where they connect to the cylinder head) also smooths out the idle. This pinpoints the problem. Vacuum sucks the choke cleaner in, enriching the mixture in those two cylinders.

Caution: Never use gasoline, starter fluid, or other highly combustible substances when searching for an air leak. Choke cleaner is acceptable, and

is commonly used by mechanics (don't use choke cleaner that's incompatible with catalytic converters). Always have an approved fire extinguisher handy. Work in a well-ventilated area, and wear safety glasses. Never stand with your face or hand directly over the carburetor throat when spraying anything into it.

3 The bearings in the universal joint have worn out, and the joint must be replaced. It's most likely that the front joint is bad. But it could also



be the rear. The "slop" (play) created by this condition results in the vibration—and the clunking noise when you shift into reverse.

4 The right front caliper is bad. Usually, when a car pulls in one direction when the brakes are applied, you would suspect a sticking brake cylinder or contaminated lining. But other things can cause it, too, such as unevenly inflated or mismatched tires. You have eliminated the other possibilities, however.

The clincher is that the pads on the right side are not worn as much as the pads on the left—indicating that the left side has done more braking.

To understand this problem more clearly, take a closer look at how disc brakes work.

When you press the brake pedal, hydraulic pressure pushes the piston out, causing both brake pads to squeeze against the brake rotor. Result: rotor turns slower or stops, depending on amount of pedal pressure applied.

[Continued]

When the brake pedal is released, the brake piston's seal acts much like a brake spring on a drum brake. The spring retracts the brake shoe when the pedal is released. The retraction of the piston by the seal is very small, but enough to allow the rotor to spin freely between the brake pads.

When corrosion, dust, or dirt builds up between the brake piston and piston housing, the piston can bind. It may not retract, leaving the brake pads squeezing against the rotor all the time. Or it may not permit the piston to move outward—as is the case here—so only one front rotor is doing the braking.

In either case, the caliper must be rebuilt or replaced. Any time brake pads on one side are replaced, the pads on the other wheel should be replaced.

The same goes for the drum brakes in the rear. If new shoes go on one side, they should go on the other, too.

5 A broken motor mount is the problem. It must be replaced. As the car accelerates, the engine is trying to rotate in the engine compartment. Two indications of this are the excessive movement of the gear-shift lever during acceleration and the tips of the fan blades hitting the fan shroud.

A motor mount is a sandwich of vibration-absorbing rubber-like material between two pieces of metal. One piece of metal is bolted to the engine, the other to the frame, or subframe, of the vehicle. There are two motor mounts at the front of the engine. And the transmission mount (where the transmission is bolted to the cross-member) serves as the third mount.

One way to check for a broken front motor mount is to raise the hood and stand at one side of the car and watch the engine. With the parking brake on, have someone start the car. Ask your assistant to apply the brakes, put the transmission in "drive," and depress the accelerator pedal slightly (for no longer than five seconds).

Release the accelerator pedal and put the transmission in park or neutral. Accelerate to around 2000 rpm for a few seconds to let the fan help cool the transmission oil. Then try the procedure again, but this time put the transmission in reverse. With the transmission in drive, you have checked one front motor mount. With the transmission in reverse, you have checked the other one. In either case, if the engine rises up on one side when the engine is accelerated, the motor

Continued

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Automotive quiz

[Continued]

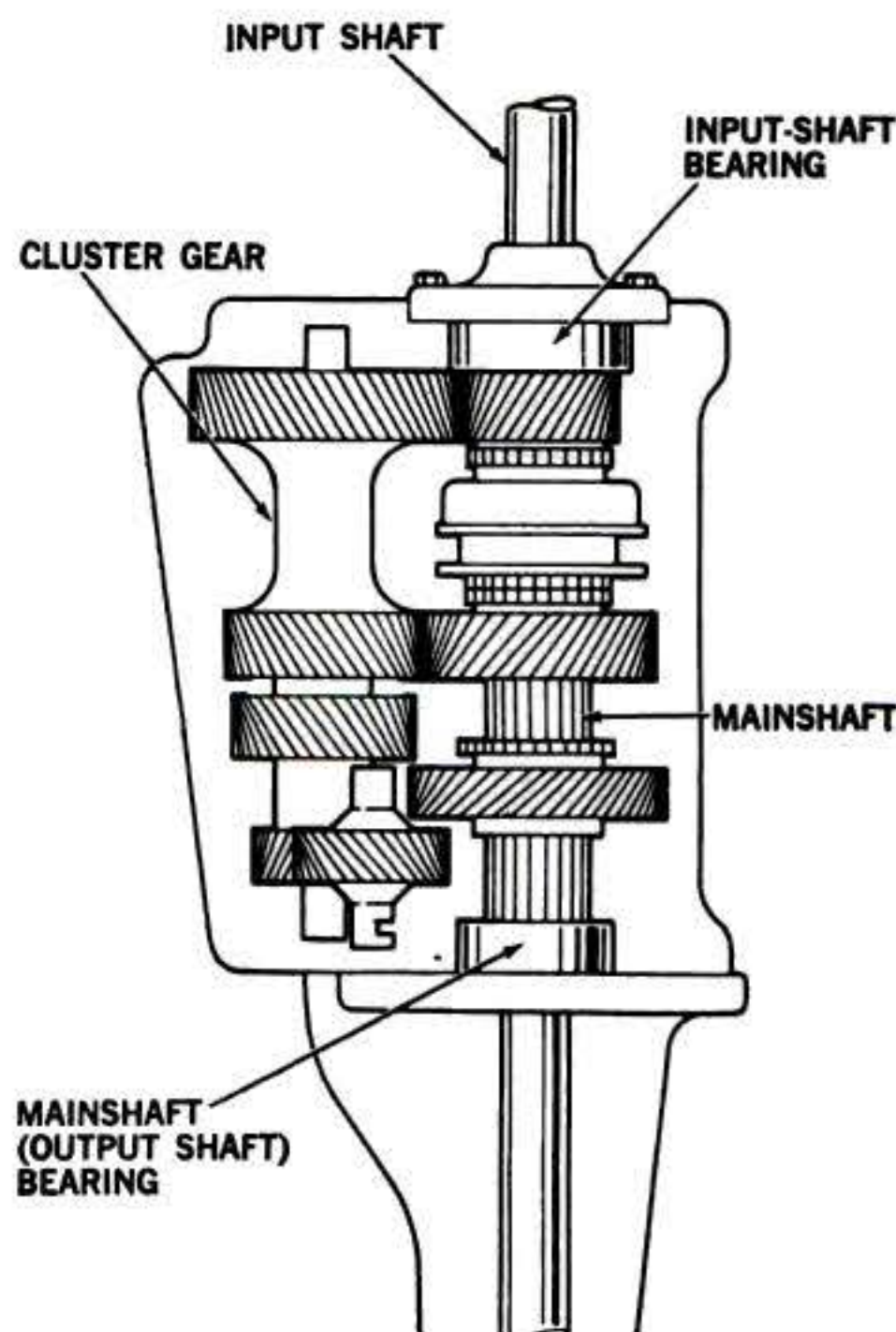
mount is broken and must be replaced.

Your assistant should have his or her hand on the ignition switch so that the ignition can be immediately shut off should a problem develop (a stuck throttle, for example). And make sure there is nobody in front of or behind the car when you make the test.

6 The noise is coming from the transmission. And the most likely culprit is a bad input-shaft bearing, which must be replaced.

You know the noise isn't coming from the clutch throw-out bearing—for two reasons:

One, clutch-pedal free-play is at spec, which means that the fingers of the clutch's pressure plate are not touching the clutch bearing. So it wouldn't be rotating with the clutch



released and the transmission in neutral—which is when you hear the grinding noise.

And, two, the noise disappears when the clutch is depressed. The clutch bearing is spinning now. But the noise has stopped. This indicates the problem is in the transmission. And in neutral, with the engine running and the clutch released, the only things spinning in the transmission are the input shaft and gear, cluster gear, and an idler gear.

It's true that bad countershaft bearings, idler shaft bearings, or a chipped gear could be the culprit, but usually such a problem is caused by a bad input-shaft bearing.

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DIY window greenhouse

By PAUL BOLON

Hanging plants can be lovely, but too many can clutter a window. One way to keep sunlight streaming in despite lots of plants is to arrange them in a greenhouse attached outside. Window greenhouses are expensive to buy—\$300 or more for an average-size window—but here's one you can build yourself for less than \$100, including the cost of materials and a Pop Brand Rivetool that you'll need for construction. And the design adapts to fit any size double-hung window.

Basic materials are 1/8-in. Plexiglas and one-inch aluminum angle (available at well-stocked hardware stores) held together with rivets. The hinged lid of the greenhouse swings up to provide ventilation. The design is sturdy and has the finished look of a manufactured product.

Dimensions of major pieces depend on the individual window size (see drawing and explanation on the following page). Once all frame pieces are cut, bolt the frame and continuous hinge together temporarily with small bolts at the corners. Clamp diagonal wood braces to square the frame and make it rigid, then cut the aluminum angle for the lid, allowing 1/4-in. clearance all around. Measure and cut the Plexiglas sides for a loose fit inside overlapping metal at the corners. With both Plexiglas sides in place, measure and cut the center and lid glazing. While framework is still temporarily assembled, mark locations for the remaining rivet holes: First, for top-shelf supports, locate and mark holes even with the top of the upper sash when it is fully lowered. For the lower shelf, mark holes eight or nine inches below the bottom of the lower sash when it is fully raised. All holes should be centered 3/8 inch from the edge of the aluminum—enough room to use the rivet tool from inside. Mark one additional rivet hole between each shelf support, and drill the 1/8-in. holes.

Peel back the protective paper at the edges on one of the Plexiglas sides, and drill and bolt one of the rivet positions near the center of each side. Remove the corner bolts of the side and drill holes in the Plexiglas to match pre-existing holes in angle. After all holes are drilled, unbolt the Plexiglas, clean off shavings, and rivet the assembly together, making sure that shelf supports go inside the Plexiglas. Proceed with drilling and riveting the other side, front, and lid, spacing rivets every three or four holes apart in the lid hinge.

Upper shelves were made from 1/8-in.-thick expanded aluminum (mesh) and angle. Size the shelves to fit loosely



Handsome greenhouse design will adapt to fit any size window.

in their supports for easy removal. Cut the expanded aluminum with tin snips in such a way that the diamond pattern overlaps the flanges of the angle equally on all sides for riveting inside the last uncut row of diamond shapes. Depending on the size and pattern of your expanded aluminum, it may be necessary to use backup plates under the rivet heads for added strength. The lift-out floor of the greenhouse is 1/2-in. exterior plywood coated with a clear water repellent. For handles, use eye bolts at each end.

An extra pair of hands will be helpful to hold the greenhouse in position while you're drilling holes and setting screws into the window casing. Final step is weatherproofing: Caulk where necessary and use self-adhering foam tape under the lip and floor. The hinge can be sealed with duct tape or capped with flashing nailed to the window trim. Two aluminum cookie sheets filled with marble chips or gravel hold water and provide humidity.

For more on the DIY window greenhouse, turn page

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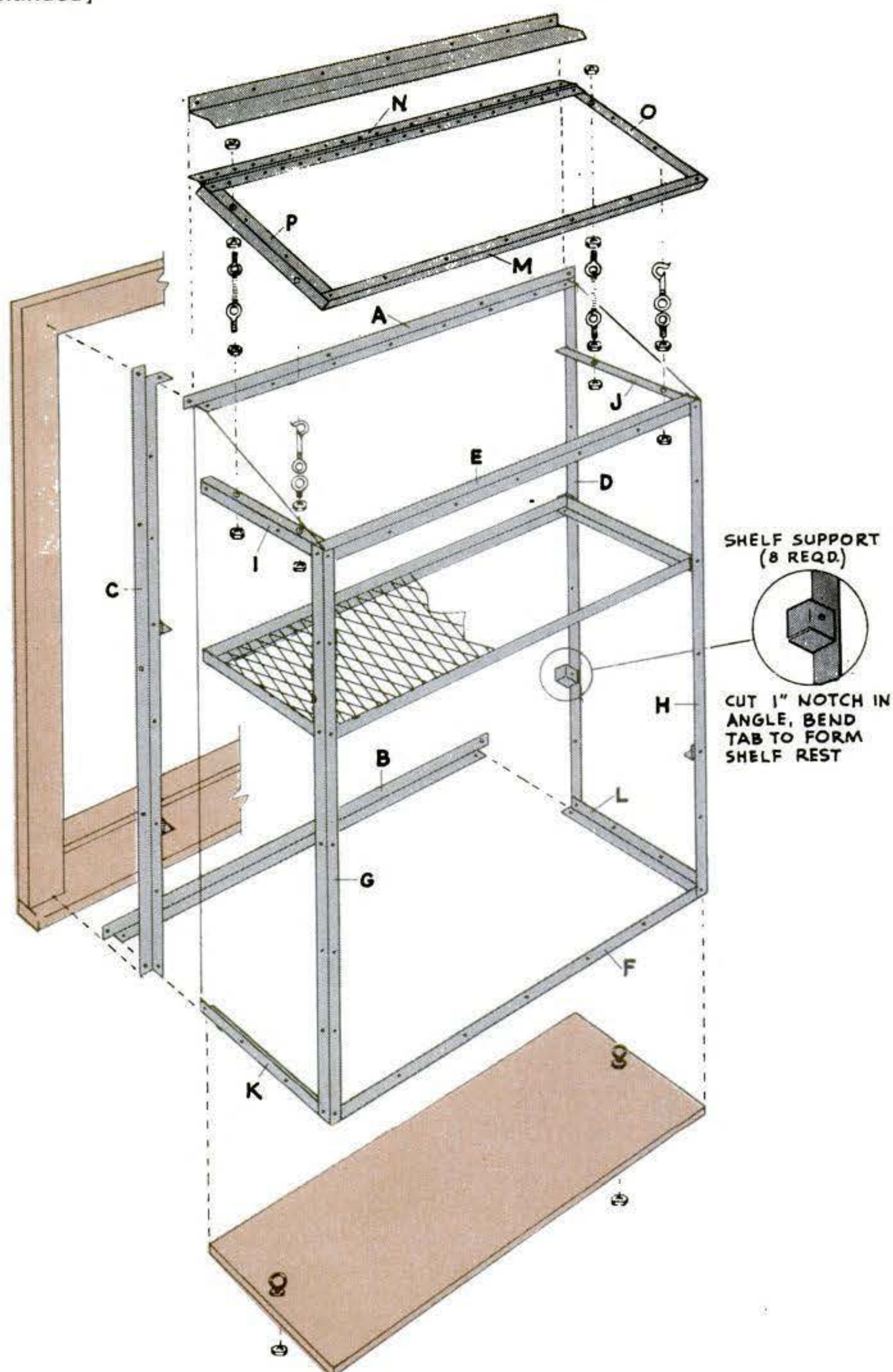
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DIY window greenhouse

[Continued]



Dimensions of major pieces depend on window size, but figuring their length is easy. First, measure width of your window on the inside from jamb to jamb; call this measurement X. Then measure the height inside the window from the top of the frame to the sloping sill; call this Y. The lengths of frame pieces are determined from these two dimensions. Top and bottom rear members A and B are X+2 inches. Rear side members C and D are Y+1. Front pieces E and F and continuous hinge N are exactly equal to X. Vertical front corner pieces G and H are Y-6. Pieces I, J, K and L are 16 inches long. Lid, shelves, and 1/2-in. plywood floor are cut to fit the finished frame.

Horizontal pieces A and B have identical one-inch notches cut out of both ends. Saw one inch down vertical rear side members C and D and bend the inner flange tabs 90 degrees, as shown. Align and drill 1/4-inch holes in the corners of A, B, C, and D, centered 1/2 inch from the

edges of the angle. Bolt inner frame ABCD together temporarily and check it against window for fit. After cutting frame parts E through L, drill 1/8-in. corner holes 3/8 inch from the outer edge of the angle for temporary bolts.

Cutting aluminum angle is easiest with a saber saw, using a coarse metal-cutting blade. Clamp angle to a work surface while cutting and drilling. File and deburr as you work. Drill one piece at a time, and for corner holes overlap mating frame pieces, clamp tightly, and drill together. One-eighth-inch Bostik rivets should be installed from the inside.

Hooks and eye bolts are used to prop up the lid for ventilation. Hooks are placed about three inches from the front of frame members I and J, and 3/16-in. holes are drilled near the edge of the lid directly above the hooks. Springs from drapery hardware are stretched between eye bolts in the lid and frame to damp wind vibration and keep the lid securely closed. **[3]**

"SAY, SMOKEY—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

Engine misses

My '74 Toyota Land Cruiser wagon has a stock six-cylinder engine with about 65,000 miles on it. Without warning it will sometimes start to miss. The engine doesn't usually die—and when it does, it starts easily.

I then have to nurse it along at about 10 or 15 mph; if I try to give it more gas the car will start to buck. It sometimes helps to use the hand choke.

This usually happens a mile or so after starting out. But on two occasions it didn't happen until I drove over 60 miles. The missing is more pronounced on a grade or hill.

Weather does not seem to be a factor, as it happens anytime. Sometimes I may have to nurse the car along for four or five miles before it starts to smooth out. It also seems to help if the car sits for a while with the engine off.

Twice I have been able to get to a garage while it was still missing, but they let it sit for an hour before road testing. It ran fine and they could find nothing wrong.

The engine has been tuned regularly by the dealer, has had two new fuel pumps, all new wiring, and a new coil and fuel filter. The problem is still there.

Ed Lane, Alexandria, Va.

Next time it misses, take the gas cap off and let me know what happens. If that cures it—and I think it will—you've got a venting problem.

Slow starting

If my 1966 Chevy 283 V8 sits for three or four days, it takes a lot of cranking to start it. It acts as if the carb is completely dry. If used every day, it starts right off and seems to run okay. What goes?

R. S. Moffat, Maryville, Mo.

Next time it sits three or four days, take the top off the carb. There probably won't be any fuel, because it leaked out the bottom of the bowl housing.

Tire claims justified?

Has there been any documented independent testing done on radial tires (regarding brand, tread design, pressures, etc.) to justify the claims of less rolling resistance and its direct relation to a percent of improvement in fuel economy?

Charles Fletcher, North Canton, Ohio

Yes, much has been done. But tires are still sold on a many-faced compromise. Take the best tire going and match it against a steel radial that has a hard tread so narrow that the total contact patch is

the same as a rubber toothbrush. Air it up to 50 lbs. Mount this light tire on a narrow, light wheel, and no tire on the market could touch it with a 10-foot pole.

Okay, now the ride is harsh. Traction is poor in wet and snow. Cornering traction is decreased.

But there is a middle ground. At 55 mph who needs lateral traction? Who needs zero aquaplaning at 80 mph on 0.08 in. of water? Who needs tires that work in snow or mud? Not everybody.

We need tires to suit specific geographical areas, and we need some work to change them to suit specific climates.

We sure don't need 1000 sizes, tread patterns, and grades. And we are long past the time when all cars should be able to use the same wheels. We need mileage.

It's time for the tire companies to quit their baloney and get busy. And it's time for Detroit to get together on a standard wheel size; imports should use it, too.

Blow-down a two-stroke?

Can a cylinder-leakage test be done on a two-cycle engine without blowing the crankcase seals?

Bob Courtney, Whittier, Calif.

Yes. But the piston must be at TDC. Very little air gets past the rings if the engine is in good condition. But since you don't know what to expect, provide a crankcase vent.

Wants better mpg

I have a '78 Scout 4x4 with a 345 V8. The best mpg I've gotten is 12. There don't seem to be many bolt-on aftermarket items to help me out of this dilemma. I've considered headers, economizer cam and/or carb, even possibly a turbo. Can you suggest what, where, and how?

Cornbinder, Lincoln City, Ore.

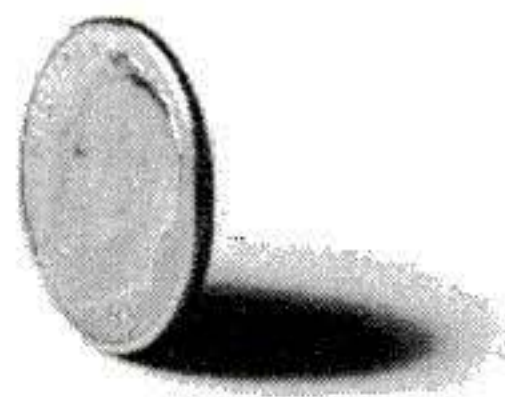
Yours is a hopeless case. You have twice the engine you need. An overdrive that would get 55 mph at about 2000 rpm would be the biggest help. Power the rear wheels only, and stop all other gear losses. Use big, hard, smoother tires. The induction system from carb to combustion chamber is too tight. The exhaust system and pumping losses are other problems. The expense and legal problems do not make this a worthwhile project.

What puzzles me is that the four-cylinder Scout is as good as the V8 is sorry. Yet nobody wanted the four.

My remarks, by the way, are based on the assumption that the vehicle is used for

Continued

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by Hale Irwin



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"Say, Smokey—"

[Continued]

transportation for standard and substandard roads. But they don't apply in situations where the vehicle was purchased to do very hard, heavy work in extremely poor terrain; here mileage isn't a factor.

Air shocks up front?

I own a '74 T'bird with very soft front suspension. It bottoms out easily on all but the smoothest roads. Is it safe to install air shocks in the front end?

Bernie Penner, Stettler, Alta., Canada

Whenever you change suspension, bear in mind that what you do to one end affects the other, and may change handling dramatically.

Even an engineer couldn't really tell you exactly what will happen unless he was one of the design engineers of your car. Maybe a shock company can guarantee results from previous experience.

When to change oil

My auto manual tells me to change the engine oil in my '76 Toyota Celica at 6000 miles or six months, whichever comes first. I recently started using public transportation and now drive the car only 4500 miles a year. The car is driven 30 miles or more per outing, which I believe is enough to burn off any condensation in the oil.

Should I still change the oil at six months with only 2200 additional miles on the car?

Jeffrey Muise, Staatsburg, N.Y.

Yup. Change it spring and fall. Try to find a use for it besides throwing it away.

Shouldn't complain

I have a 1971 Mercedes with a 2.2-liter, four-cylinder engine and manual transmission. At about 100,000 miles, it started to use oil between changes (5000 miles—oil and filter), but not enough to add a quart. Now, at about 147,000 miles, I have to add a quart between changes. My question is: Would switching to a different oil such as 10W40 or 10W50 help? I have always used 30W.

The real problem is that overhauling this engine could be expensive, so I would like to avoid this as long as possible. It gets 20-mpg city and 25-mpg highway, and the body, steering, and suspension are still solid, so the car is worth keeping for a while longer.

Raymond Stenbroner, Cupertino, Calif.

Don't change brands now. Use a heavier grade, maybe. I believe your rings are more likely stuck than worn out.

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—," *Popular Science*, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

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Isn't it about time, you found out, the misunderstanding that most people have about becoming Financially Secure?

As incredible as this may sound, there is a way to accumulate great wealth without working sixteen hours a day, every day, for the rest of your life. But, because of the bold implication of this statement, I would like you the reader to be the judge.

My name is Robert E. Shindler. I wrote a book entitled "The Get Rich Report," but I am **not** going to tell you how to become a millionaire. Furthermore, I am **not** going to show you how to become rich overnight. What I am going to tell and show you are ideas and methods that have made people from all walks of life successful, independent and financially secure for the rest of their lives.

If you are still with me this far, and I hope you are, I would like to share with you some of my accomplishments that I have included in my new book.

Now I know that you expect me to tell you about some "secret success formula", that I found in the attic of some old mansion. Or that I spoke to and studied the richest and most powerful men in the country. **Not true.**

Quite the Opposite

What I learned over the past five years about success and financial independence was quite the opposite from any formulas that you may have heard or read about.

Take Robert Gorman, a middle-aged man from Alexandria, Virginia. He works as a carpenter restoring old houses, because he likes it, and has a net worth of over a million dollars. He owns two office buildings and twenty-five houses (all of which he accumulated over the past seven years starting with nothing).

And then there is Alice Ragan who is a widow with four children from Arleta, California. Five years ago she was flat-broke and so heavily in debt that she came very close to applying for welfare. Today she has over \$250,000 in the bank and 35% ownership in one of the states largest corporations. All of this was acquired by using the same ideas and methods that Mr. Gorman used.

I found that these two cases were not isolated by any means. From one end of the country to the other I talked to small groups of people from all walks of life (all applying and using the same ideas and methods). All starting without any capital and all becoming financially secure.

Definitely Different

The methods and ideas were definitely different. The concept was unique and far superior to anything in any book I had ever read.

I began by putting the information and methods I had learned into practice, revising and improving them to work even faster. I was amazed at the results in just six months.

Today I am my own boss and I am spending a lot of time traveling around the country doing things that I only dreamed about before.

In the first six months of operation, with just one of my methods, I earned over \$100,000. The second half of the year I doubled that figure. After three years of perfecting my methods, I am the president of my own corporation which planned a series of acquisitions back in 1978 which by 1984 should surpass the \$4 million dollar mark.

I'll tell you one thing: anyone can make

\$200,000 a year using my methods and ideas and they would be a fool not to try. Things are tough for people living on salaries. Tomorrow they'll be even tougher.

All over America new fortunes are being created. People from all walks of life are embarking on an adventure that few experiences in life can match: A journey into excitement, success and — just possibly — great wealth and the kind of personal freedom that few others will ever enjoy.

The Real Proof

But you will find the real proof of my accomplishments in the last eleven chapters of my book. I will show you that you don't have to be a genius. I'm definitely not. You will find that you don't have to live in any particular part of the country. Nor do you have to have experience or outside financing.

My book "The Get Rich Report" will show you more than how to make a substantial income and become financially secure. It will stimulate your mind and reveal to you NEW ideas and methods that will work for you NO MATTER what kind of job or business you are in. I have already received many letters from housewives, lawyers, businessmen, doctors and government elected officials who have thanked me and profited from the ideas and suggestions in my book.

\$2,800 in Twenty-Eight Days

"I am a retired railroad man 75 years of age. I used to just sleep all day and watch TV at night. Now that I received your Get Rich Report, I have something to do with my time and making money besides. Last month I made \$2,800 using your methods. I could easily double that if I were a younger man. I feel useful again."

Thomas Sheehan

Saginaw, Michigan

A Blueprint for Success

"I am a school teacher. Before that I was in show business — New York, Dallas, Europe. Also wrote for Broadway shows. After seeing a sample of your work I can only say; your systems are like a blueprint for becoming successful. You can count on me. My goals are set very high!"

John McCall

New York, N.Y.

\$24,000 in Four Months

It seems all my life I've been faced with bills, bills, and more bills. I was always up to my ears in debts, and there never seemed to be any let up. If it wasn't one thing, it was another. I just couldn't get my head above water. Since I started using your methods in your book I've gained a second income of \$24,000 in just four months, besides my regular salary. I am now free and clear of unpaid bills, I have \$34,000 in savings in the bank and I have just purchased a new home \$125,000. It seems like I have a new lease on life.

John Seals

Indianapolis, Indiana

\$14,028.77 in One Week

Five days after your book arrived I set one of your plans into action. I made \$14,028.77. I have never in my life time, seen a program work so fast. PS. I still don't have a job.

Joseph Altizer

Springfield, Illinois

\$32,000 in Just Three Months

Three months ago I took what you taught me in chapter 10 to heart. The results were remarkable. I made \$32,210.00. Not bad for a person with a seventh grade education.

Samuel Thornton

Riverside, California

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Through all my years as a United States Congressman, I have been exposed to scores of ideas from all parts of the country.

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Roger H. Zion

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Those were just some of the comments from people, just like yourself, from all walks of life and various parts of the country. The only difference between them and you is their use of certain basic principles taught in The Get Rich Report. In just one week from now you can know what they know.

I have written the book in plain English to make it easy to read and easy to follow. If you are asking yourself about now, "I wonder if his book is about mail-order?" let me answer you by saying you are dead wrong. The Get Rich Report has ABSOLUTELY NOTHING to do with or about mail-order.

You will find twenty-one chapters that are full to overflowing with facts, methods, ideas and techniques, that are working for me and several hundred others across the country. Methods like: A six month step-by-step plan for building a \$200,000 income without having a job or business. Or the system that allows you to receive \$10,000 two weeks after the book arrives.

You will find that you don't need an education to make these methods work. Nor do you need lots of experience. Both men and women, all ages, are acting on my seasoned advice. What is required? A willingness and a determination to put this knowledge to work for you and your family. Believe me when I say, it does not require you to leave your present job or business and there is positively No Selling or buying of any products. In fact, you don't need to have or rent an office to get started. You can do it anywhere — out of your house or in your apartment. With my methods and ideas you will be able to earn an extra \$5,000 to \$100,000 in a matter of months.

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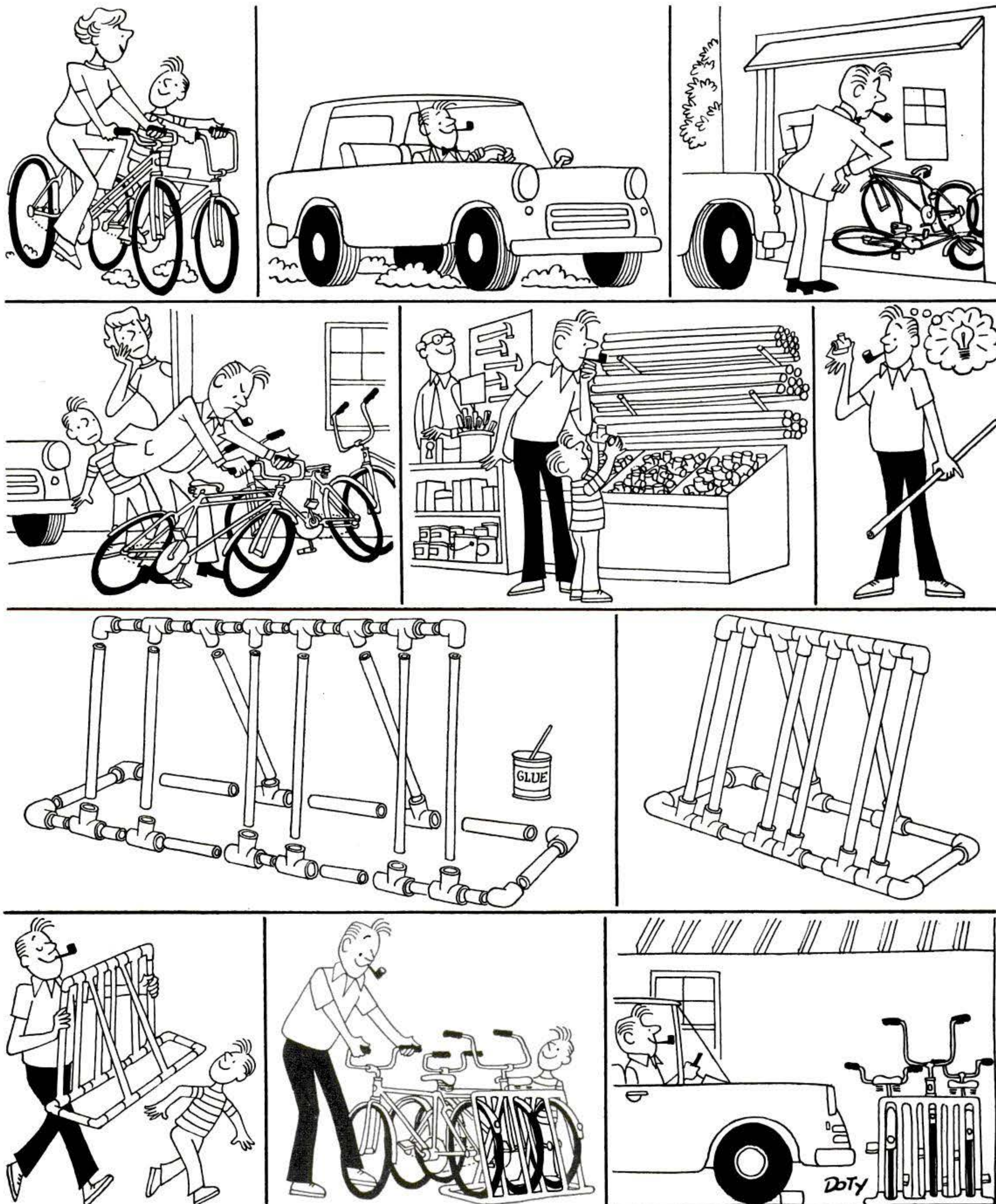
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By ROY DOTY

\$50 to John Christian of Northridge, Calif., for this idea. Send yours (with Social Security No.) to Wordless, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas can be acknowledged.



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The CAIRFree Air Freshener's patented process electrostatically creates these same charged oxygen molecules that permeate any enclosed space and attract odor molecules like a magnet until they're totally "neutralized."

BEFORE CAIRFree

There were two ways to control odors: Dilute—constantly recycle fresh air to dilute odor molecules or deodorize—constantly mask odor with a heavy perfumy scent. Now, with CAIRFree, there's a third, more effective and highly scientific way. And that's to destroy all organic odor molecules electronically.

WHAT THE CAIRFree IS NOT

It's not a one-shot cover-up. It doesn't mask odors—it destroys them electronically. And it kills tough odors continuously—not temporarily like sprays, wicks, stick-ons, etc. There are never any chemicals to buy, bulbs to burn out or filters to replace. The unit uses only as much electricity as a 25-watt light bulb.

WHAT IT IS

The CAIRFree is a continuous air-cleansing process so unique it's patented. It uses the latest in space-age electronic technology to create the first energy and cost-efficient air purification system for the home. Even in a smoke-filled room, you will be breathing only clean, fresh air all day long.

FORCED AIR—THE MOST IMPORTANT NEW FEATURE INNOVATION

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A DUST-FREE ENVIRONMENT: AN UNEXPECTED BONUS

The CAIRFree also de-activates dust particles suspended in the air. The ionized oxygen pumped into your room will attach itself to any impurities in the air, causing them to fall to the ground. Ahhhh... what's left is pure, clean air.

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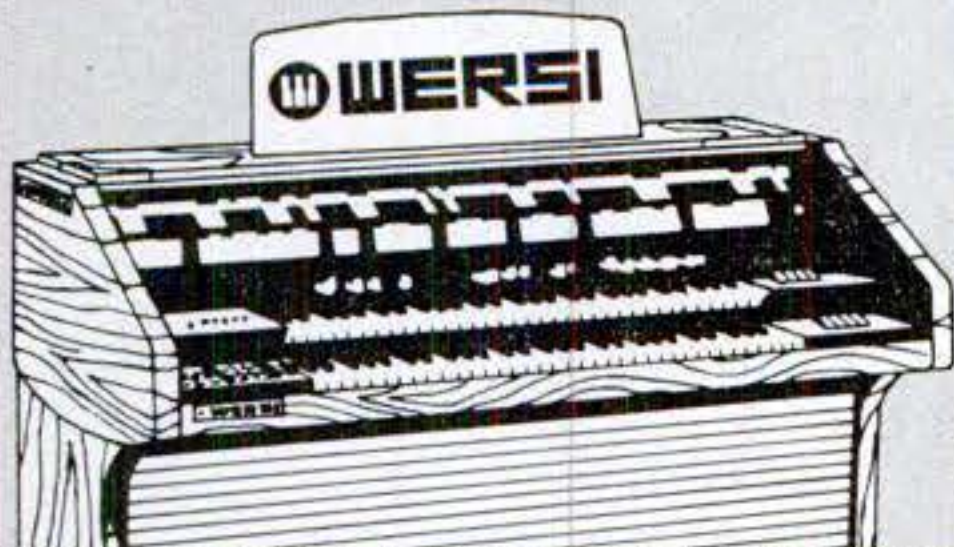
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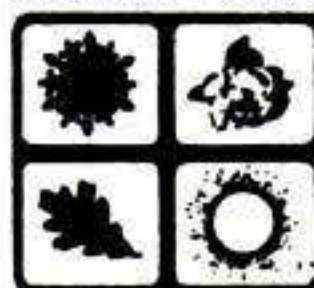
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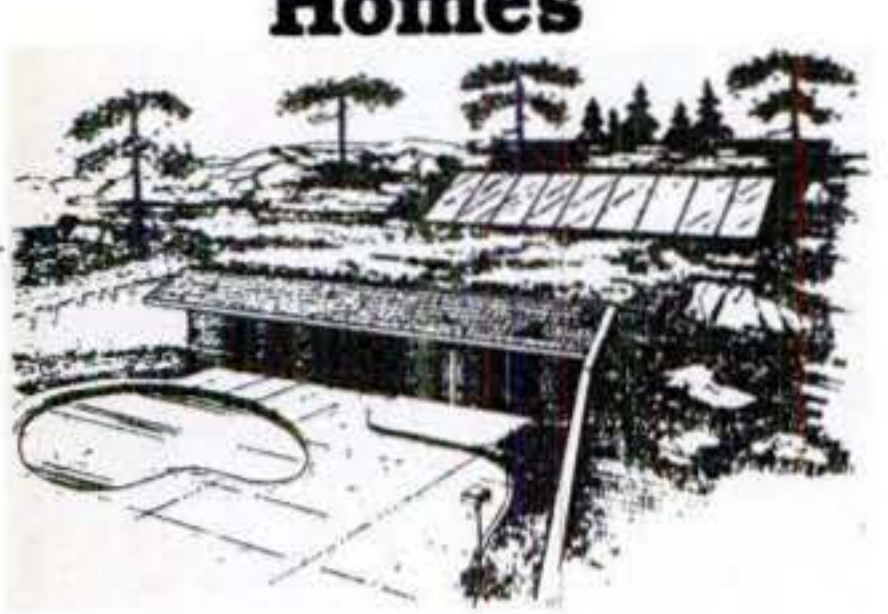


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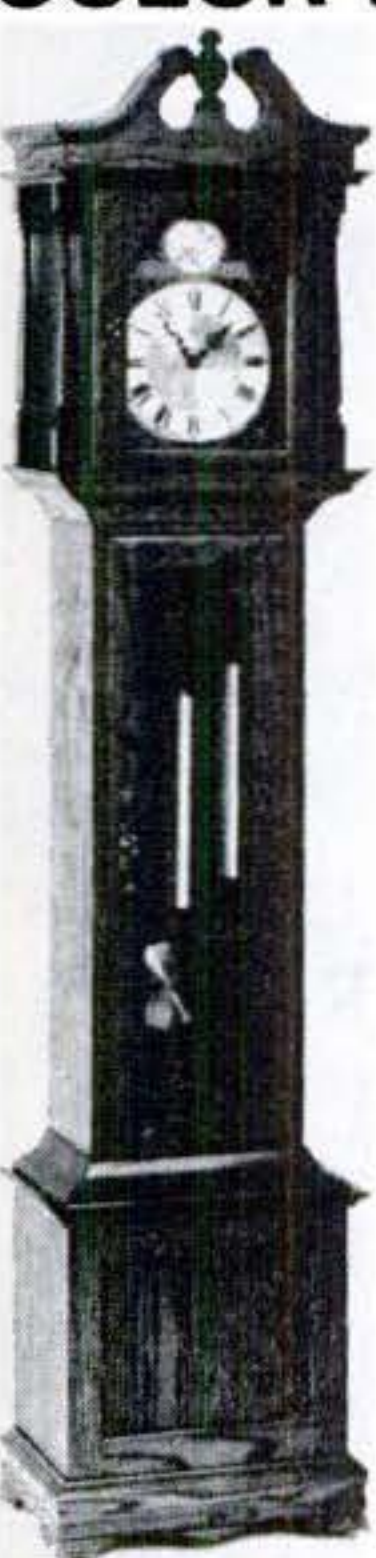


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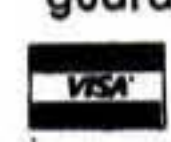
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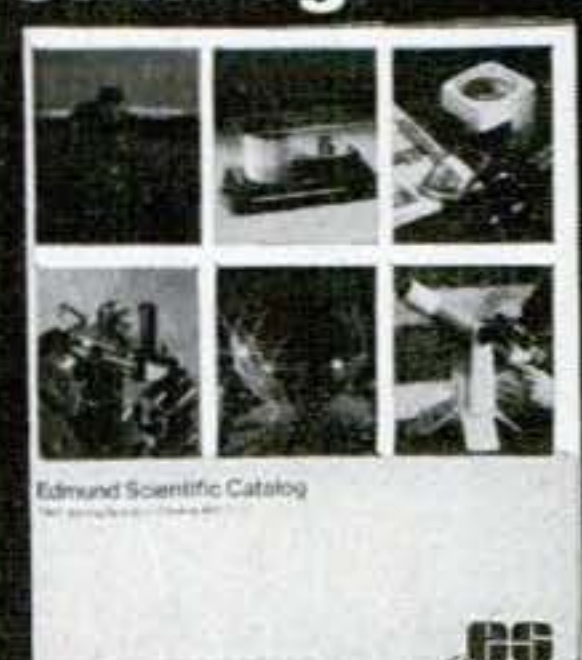
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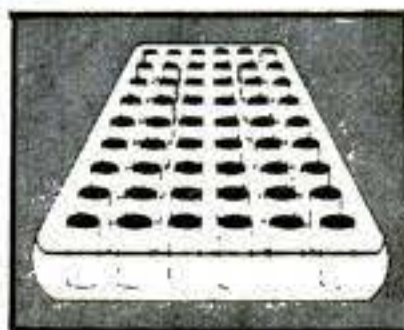
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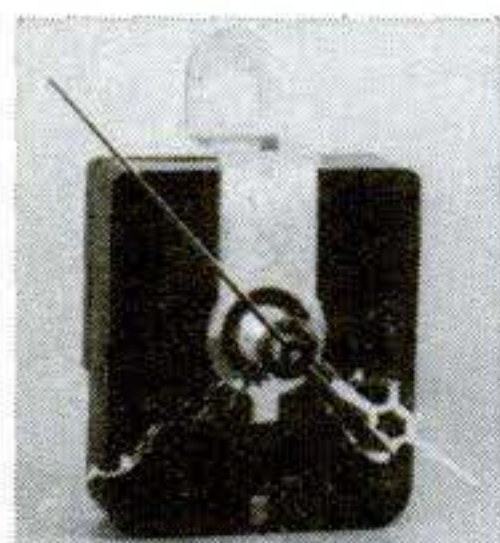
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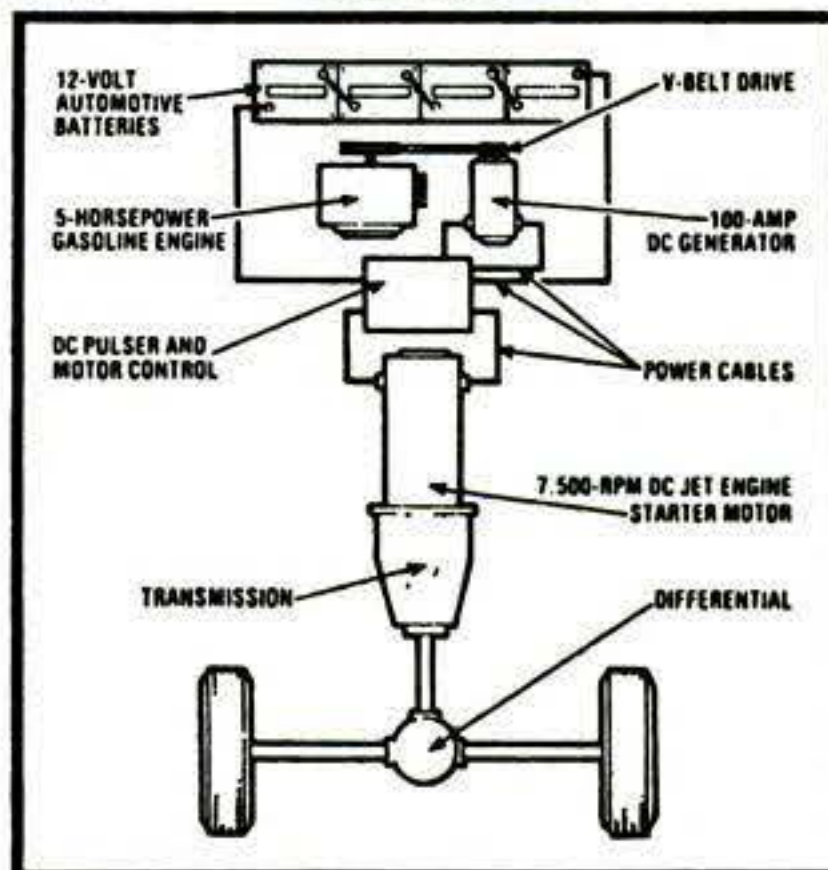
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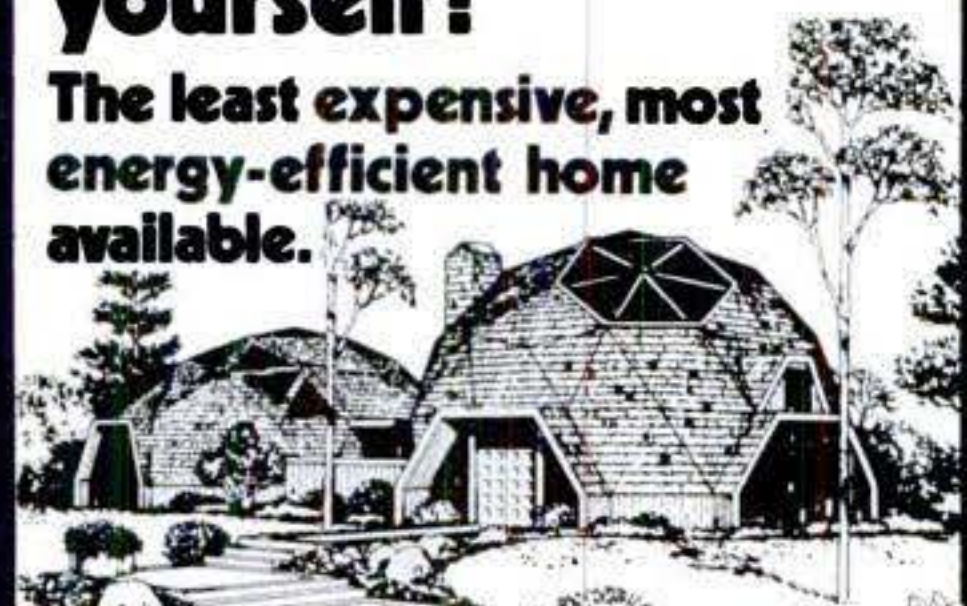
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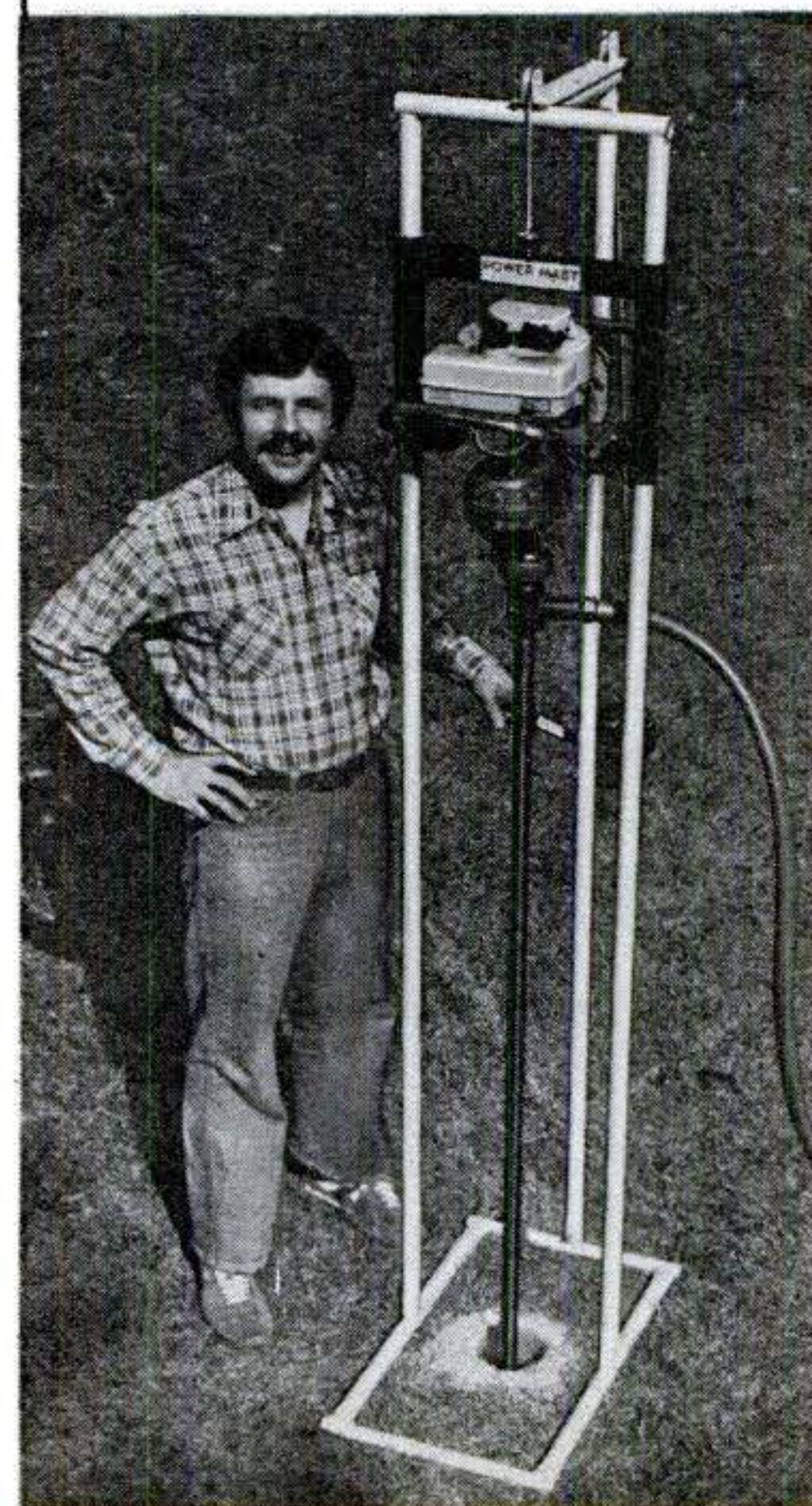
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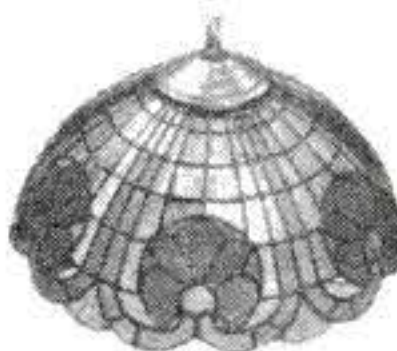
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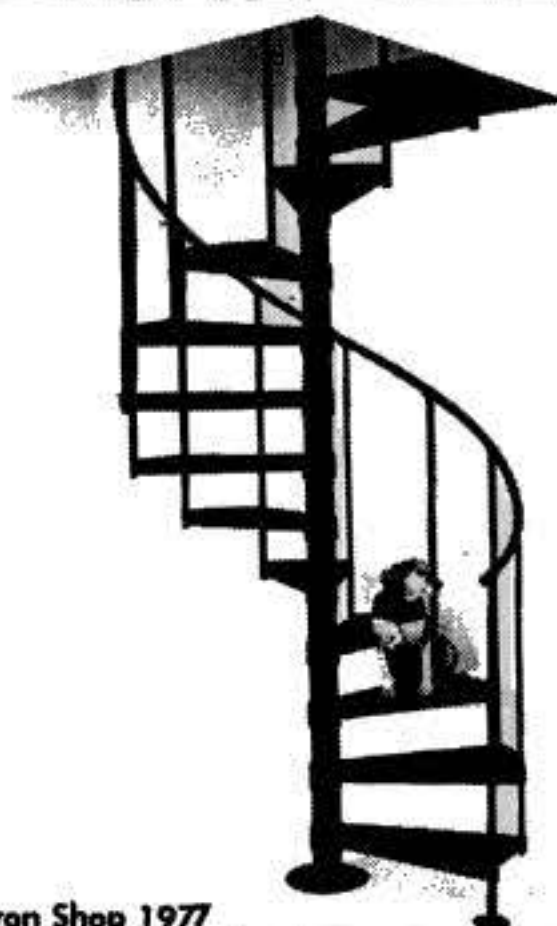
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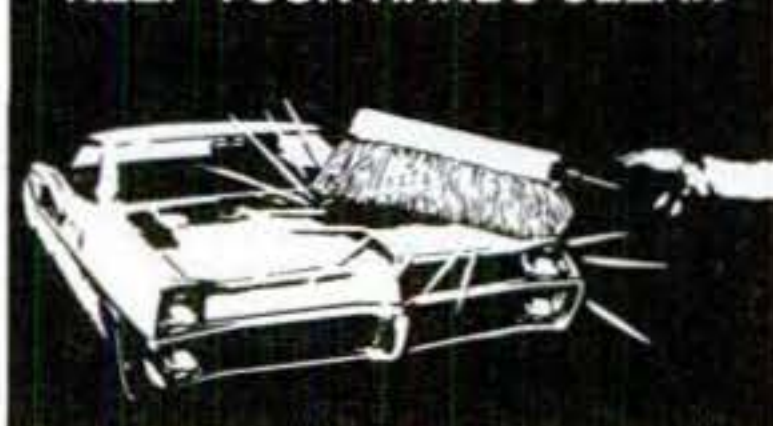
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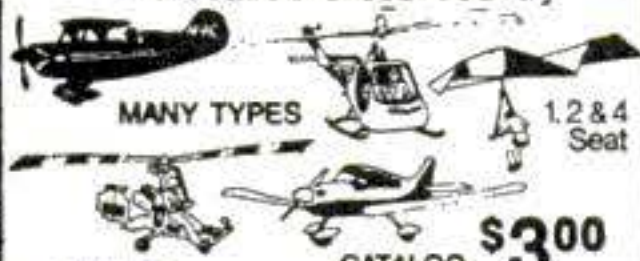
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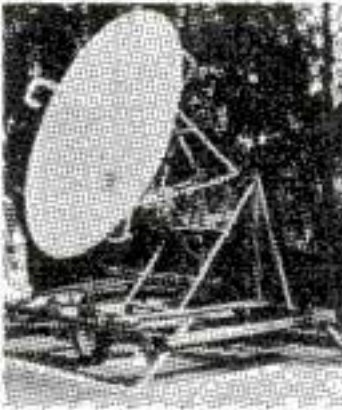
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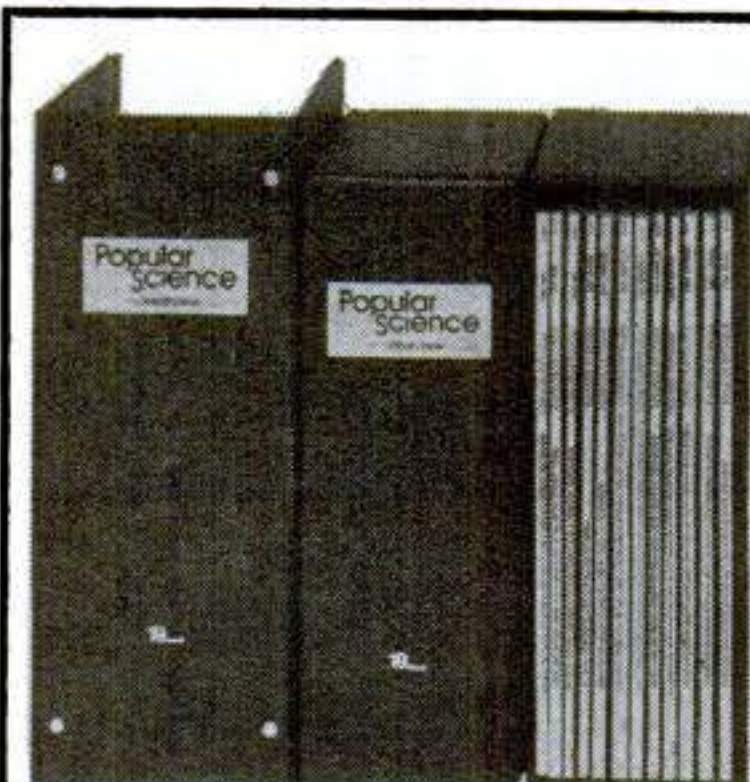
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Emergency power

for your home

from battery/inverter system

By E. F. LINDSLEY

When Steve Paul pulled the main power switch to his home I expected a few seconds of total darkness followed by light bulbs glowing a dull orange and eventually coming to life after his emergency backup system struggled to pick up the load. I also expected to hear the refrigerator and furnace blower motors click futilely for a few minutes on low-voltage cutout.

None of this happened. I saw only the briefest flicker of the lights, and the furnace and fridge kept right on running.

"The switchover from line to inverter power takes only 40 milliseconds," said Paul. Steve Paul, vice-president of Best Energy Systems for Tomorrow, Inc., was showing me the company's new 5000-watt battery/inverter home emergency-power system. "There's no noise, no problem getting an engine started, and no handling of oil and gas," he added.

So far, I was impressed. But what about picking up other loads with the lights and motors already on the line? As I watched, he switched on the clothes-dryer motor and opened a tap on the laundry tub until the one-hp well-pump motor came on. There was no problem; no halting start. Afterward, Steve took me upstairs and randomly switched on lights, the TV, a huge electric organ, and a microwave oven.

"Naturally," said Paul, "you'd select your loads and run only the important things in a real outage, but I wanted to show you what a 5000-watt inverter can do."

Inverters change direct-current battery power into 60-Hz alternating power at, for ordinary uses, 120 or 240 volts. One type uses a DC motor to drive an AC generator. Others are huge industrial installations that provide backup at utility control boards and the like. And, at the other end of the scale, small units are available to give you 60-Hz power from your RV battery.

Between these industrial and recreational extremes there have been problems with weight, cost, heat, efficiency, waveforms, and, as a home-standby unit, the sheer capacity to

handle the loads in a typical house. The Best inverter appears to have beaten most of these challenges.

Steve Paul's inverter is connected to the house lines through an automatic transfer switch. When the power fails (the equivalent of pulling the main switch in Paul's demonstration), the transfer switch immediately cuts over to inverter power. Since the inverter batteries are on continuous charge, all systems are "go" in a fraction of a second.

That's impossible with a gas-powered generator. An engine must first crank and start. At best, a highly sophisticated hospital standby set can be on line in six seconds.

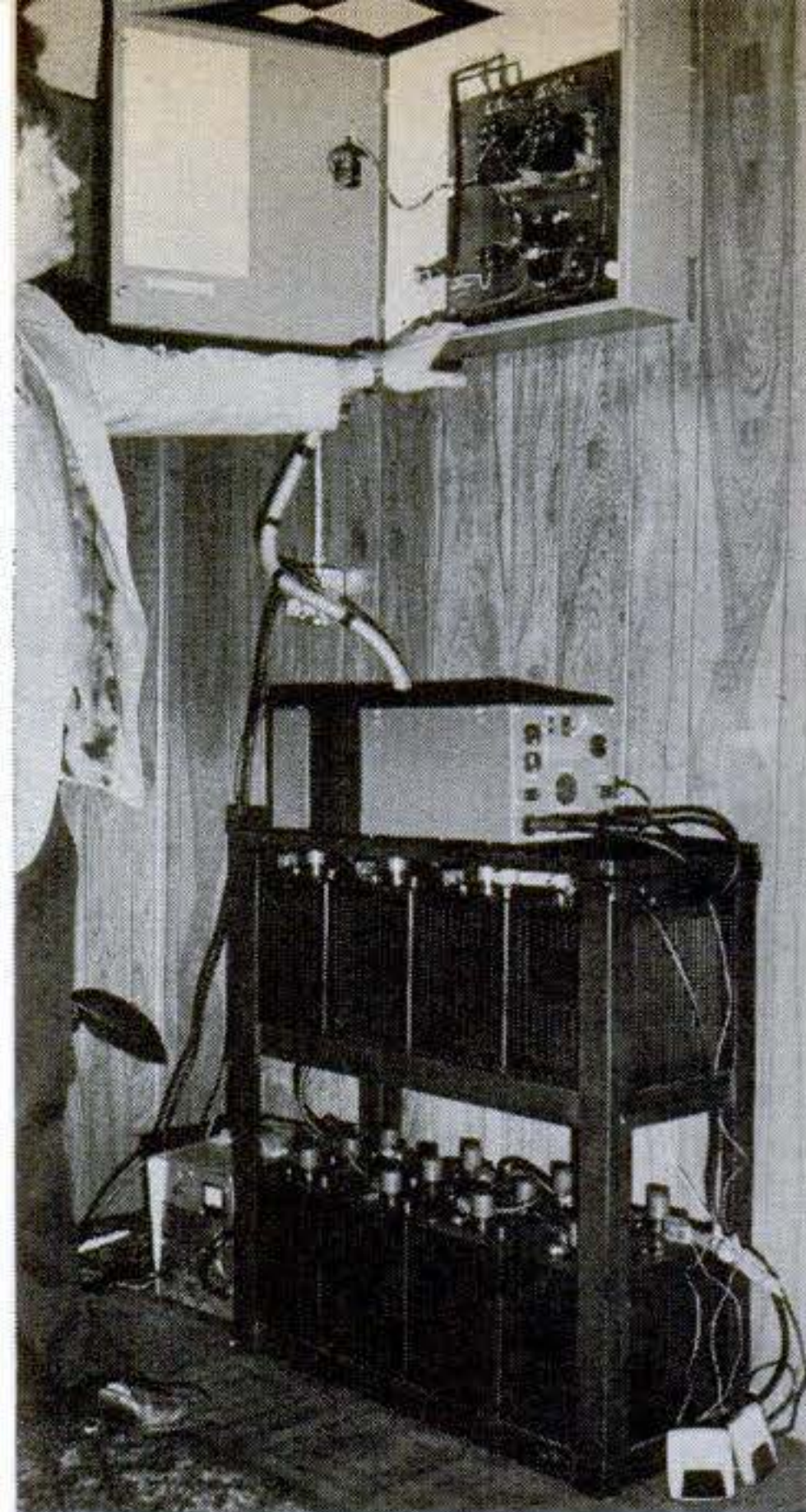
Instant power and no noise and fuss aside, there are other aspects of the Best battery/inverter system to consider:

- About the size of a breadbox, the 5000-watt unit weighs only 111 lbs.
- Batteries add to the bulk and weight. The eight batteries of the 48-volt input are neither small nor light.
- The Best unit is 90 percent efficient and uses only 1.7 amps at no load.
- Frequency regulation is five Hz.
- Surge power for motor starting is 20,000 watts.

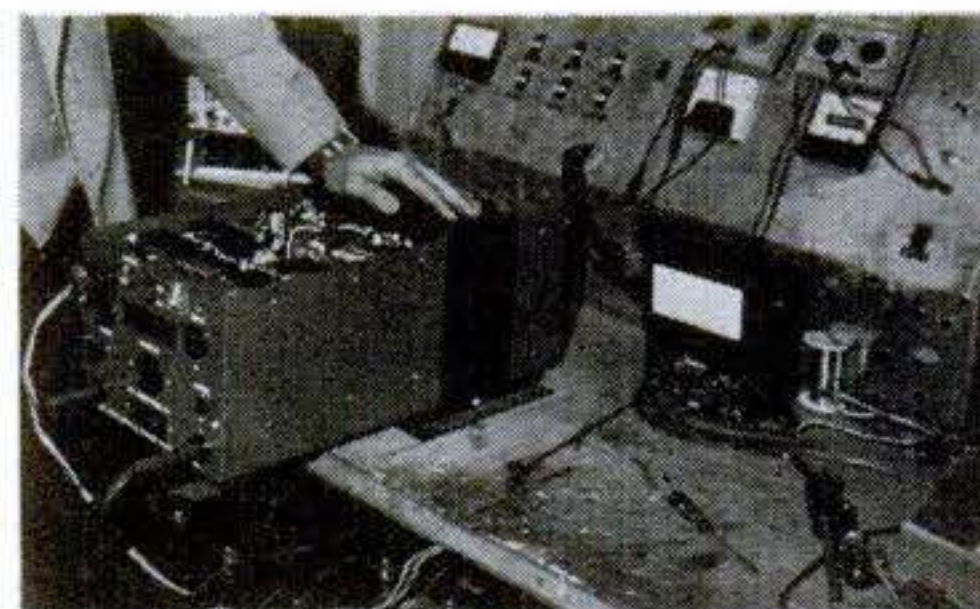
I asked Paul how long his setup would keep his house going in a real outage. "About two days," he said, "if you use your power with good judgment." Battery life? "I expect 10 to 15 years," he told me, "but I've got a special charger that manages the charging very precisely."

Aren't you afraid, I asked Paul, that hydrogen from the batteries might cause an explosion in the basement? "No, we use special caps on the batteries that take care of the hydrogen catalytically," he said. "We're very careful about that."

One objection I could see to Best's battery/inverter system was that a long outage could exceed battery storage hours. Another objection might be cost. You can buy a 5000-watt, single-cylinder gasoline-engine-driven alternator with electric start and a battery for less than \$1000. That compares with a list price of \$2358 for the inverter plus the heavy-duty, deep-dis-



Steve Paul checks automatic transfer switch that instantly cuts in 5000-watt inverter when power fails. Eight batteries provide two days' power.



Solid-state inverter has no moving parts. Waveform is different from other inverters', suits most electronic gear. Ninety percent efficient, unit wastes little energy.

charge batteries and charger. On the other hand, the one-lung alternator is in no sense automatic starting, has only primitive voltage and frequency control, and requires maintenance. Upgrade the engine unit to do what the inverter can do and you're going to spend as much or more money.

Even so, if the cost differential seems high for occasional use, it suddenly reverses when you put the inverter and batteries (in the smaller 1000-2500-watt sizes) on a cart and put them to work eight hours a day at a construction site. Since the system uses power only when you switch on a tool, is noiseless, fire-safe, and always ready to go, takes no fuel or oil, and doesn't need overhaul, it can cut hourly operating costs to one-tenth that of an engine-driven generator.

For information on Best inverters in all sizes, send \$1 to Best Energy Systems for Tomorrow, Inc., Box 280, Necedah, Wis. 54646.



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